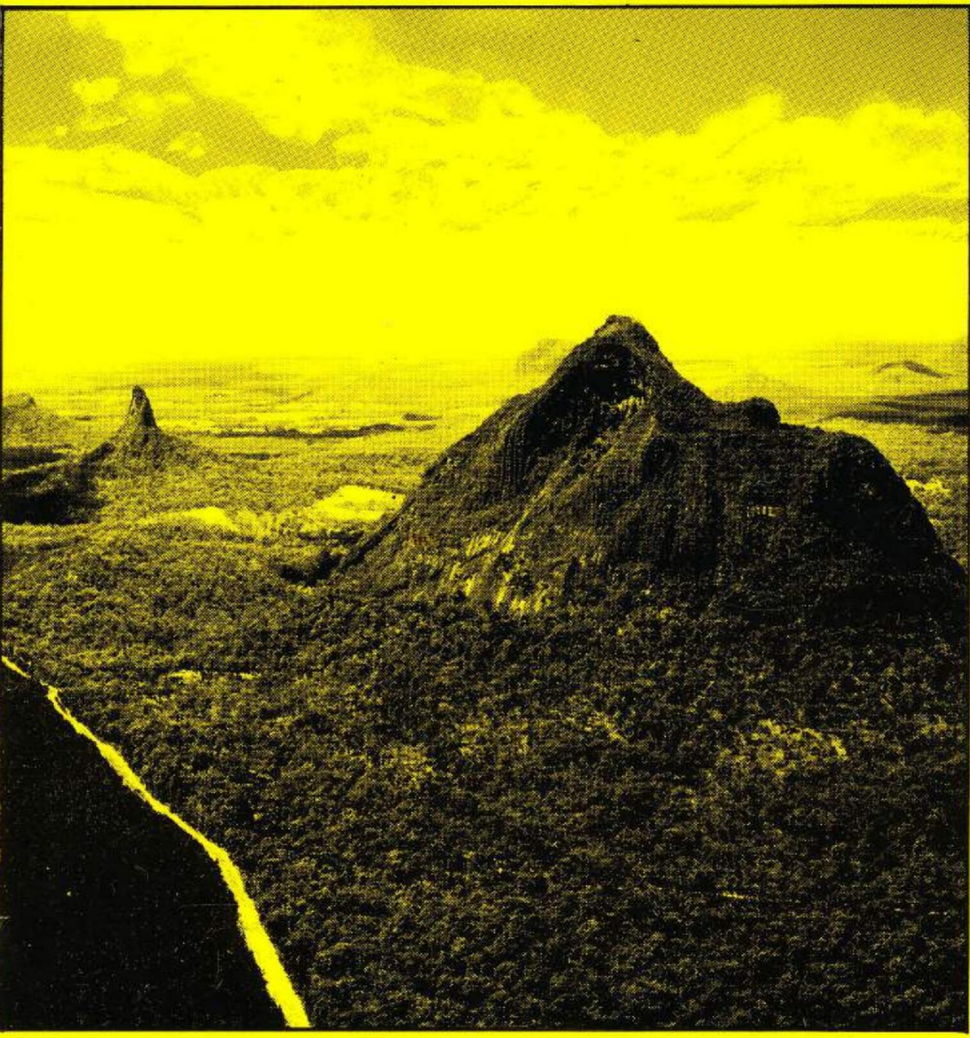
QUEENSLAND FIELD GEOLOGY GUIDE

N. C. STEVENS



QUEENSLAND
FIELD GEOLOGY GUIDE

N. C. STEVENS

Department of Geology and Mineralogy
University of Queensland

QUEENSLAND DIVISION

Geological Society of Australia (Queensland Division)
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1984

Cover photo (by courtesy of the Premier's Department, Queensland):
Mounts Beerwah, Tibrogargan and Ngun Ngun, Glass Houses, Q. looking east.

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INTRODUCTION

Previous guide books for geological excursions in southeast Queensland by the present author were published in 1965 and 1973. Both books are now out of print, and revision of the later guide book has become necessary because of advances in knowledge of the regional geology and changes to rock exposures and access to them. The geographic scope of the previous book has been extended to include some excursions in northern Queensland. Most of the localities have been visited recently and checked by the author, with the exception of the Mt Isa region; for this R.E. Russell has compiled several tour itineraries for Mt Isa Mines Ltd, which have been slightly condensed and incorporated in this book.

Because the publication of details of geological sites on private land might cause a nuisance to landowners (and disappointment to excursionists if refused permission to enter), detailed descriptions of geological sites in this book are mostly restricted to those accessible to the public such as roadsides, reserves, vacant Crown land and National Parks. Permission should be obtained to enter private land, land under lease, Council or Shire land (e.g. some quarries) and Forestry areas.

There are strict rules prohibiting collection of rocks and minerals in National Parks. In other places, collection of specimens should be undertaken carefully, so that geological structures are preserved, and not disfigured by hammer marks. Fossils and uncommon minerals should be collected from fallen debris if possible; the 'in place' occurrences should be left for others to observe. Many fossils are of great scientific value, but this value is lost if they are collected, only to be hidden in private collections and eventually discarded. Well preserved collections from accurately recorded localities should be offered to Museums or University Geology Departments.

To supplement the maps in this book, it will be useful to have topographic maps, on scales of 1 : 100 000 or 1 : 50 000, obtainable from Sunmap or Watson Ferguson Ltd, Brisbane. Coloured geological maps, on scales of 1 : 100 000 (for parts of southeast Queensland) and 1 : 250 000 (for northern and inland parts) have been published, and those still available may be obtained from either the Geological Survey of Queensland or the Bureau of Mineral Resources, Geology and Geophysics, Canberra. Geological maps on smaller scales include 'Moreton Geology' (1980) and 'Queensland Geology' (1975). The companion volume (Publication 383, Queensland Geological Survey, 1983) to the latter gives an up-to-date summary of the geology of the State.

The author is indebted to many geologists for written and verbal information on areas which they have investigated, to those who have accompanied him on field trips, to those who have read parts of the book and have made useful comments, to W.D. Smith and J.R. Blair for their help in organizing the Mt Isa contribution, to Mrs E. Burdin for drafting the maps, and to the typists of the Department of Geology and Mineralogy, University of Queensland.

University of Queensland Press gave permission for parts of 'A Guidebook to Field Geology in Southeast Queensland' to be reproduced. Some travel funds were supplied from University of Queensland research grants. The author is grateful to the Committee of the Geological Society of Australia, Queensland Division for providing funds to make this publication possible.

OUTLINE OF THE GEOLOGICAL STRUCTURE AND HISTORY OF QUEENSLAND

Reference to a geological map of Queensland shows that the State may be divided geologically into:

1. A long belt of folded rocks, mostly of Palaeozoic age but with inliers of Precambrian age in northeast Queensland, following the coastal ranges and extending inland for up to 400 km. The general trend of these rock units is about N 30° W.
2. A large area of Mesozoic rocks in the interior extending to, or close to, the coastline in the far north and in the southeast corner of the State. These rocks are very gently folded and are partly covered by thin deposits of Cainozoic age.
3. A smaller area of Precambrian rocks, the older units strongly folded and metamorphosed, flanked by Early Palaeozoic strata, in the northwest.

These areas correspond broadly to the geomorphic or landscape regions known as the Eastern Highlands, the Western Plains and the Northwestern Uplands, respectively.

The Precambrian rocks of the Northwestern Uplands (Mt Isa Inlier, 1, Fig. 1) and those of Georgetown (2, Fig. 1) and Cape York Peninsula (Coen and Yambo Inliers 3, Fig. 1) in the northeast, form complex stable blocks, parts of the Precambrian shield, which were originally unstable depositional areas at or near continental margins. Great thicknesses of sedimentary and volcanic rocks accumulated, which were subsequently folded, metamorphosed, and intruded by granites during the Middle Proterozoic. In the later Precambrian and early Palaeozoic, sediments were deposited in shallow seas on the margins of the northwestern stable block (Georgina Basin, 4, Fig. 1).

The belt of Palaeozoic rocks of the Eastern Highlands began to form in northern and central Queensland in the Cambrian and Ordovician, and continued past the close of the Permian and into the Triassic Period.

This region of deposition, once called the Tasman Geosyncline, is a fold belt, now known as the Tasman Orogenic Zone. Several cycles of deposition and subsidence followed by folding and granitic intrusion then uplift and erosion, took place. These processes resulted in the enlargement of the continent (or craton) in an easterly direction at least to the margin of the present continental shelf.

Sedimentary basins occupying depressions between fold mountains received sediments eroded from the highlands; some of these were marine, others freshwater, and conditions often changed during the history of a basin. It is customary to refer to the older, elevated areas as 'structural highs' or 'blocks', especially if they are folded and metamorphosed. The more important basins and blocks are listed in Table 1 and shown on a map (Fig. 1).

Volcanic activity was prominent throughout the history of the Orogenic Zone, evidenced by lava flows and beds of ash interlayered with sediments. Intrusion of granite was usually associated with periods of folding; in some places the magma may have reached the surface, as shown by the close association of large volumes of silica-rich extrusives (rhyolite, ignimbrite) with granites of the same age. Magma derived from deep beneath the earth's crust was injected along great thrust faults, producing serpentinite belts.

After the close of the last major orogenic cycle in Permian and Triassic times, most of the State was exposed to erosion, and sediment was carried into freshwater lakes. Volcanic activity accompanied sedimentation in the southeast and coal was formed in freshwater swamps.

The major depositional area in the Mesozoic was the Great Artesian Basin of inland Queensland and adjoining States. It was largely freshwater, but became marine in Cretaceous times, when the sea entered from the north. In the southeast, it is continuous with the Moreton Basin (22, Fig. 1), which may have had a connection with the Nambour Basin (23A, Fig. 1).

In most areas, the Mesozoic rocks (after Early Triassic) are only very gently folded and in many places are horizontally bedded. Stronger folding is seen in the Maryborough Basin (23, Fig. 1) and Esk Trough (19, Fig. 1), and in these only of the Mesozoic basins are plutonic intrusions found.

The Great Artesian Basin is subdivided into the Carpentaria Basin (27, Fig. 1), with an offshoot basin, the Laura Basin (24, Fig. 1), the Eromanga Basin (26, Fig. 1) and the Surat Basin (25, Fig. 1). The Jurassic Mulgildie Basin (unnumbered in Fig. 1) is shown between 17 and 14 (Fig. 1). The Triassic Ipswich Basin is shown on the inset to Fig. 1.

By the end of the Cretaceous Period, the large freshwater lakes of the Mesozoic Era had been converted to land areas. At this time and subsequently, much of inland Queensland was undergoing lateritic weathering. During the Tertiary Period, continental sediments accumulated in downwarps, and basaltic volcanism was widespread in the eastern part of the State, especially during Oligocene and Miocene times. Uplift during the Tertiary raised the Eastern Highlands and rejuvenated the river systems. Some block faulting near the present coast resulted in narrow basins in which sediments, including oil shale, were deposited.

The continental shelf received land-derived and carbonate sediments; the later part of the Tertiary and Quaternary Period saw the development of the Great Barrier Reef. Coastal regions were affected by world-wide sea-level changes; high sand dunes and beach ridges developed along the southern coast in Pleistocene and Recent times. Inland sediments were deposited by the western and Gulf rivers, and desert sand dunes formed in the far southwest. Volcanism continued in north Queensland during the Pliocene and Pleistocene, with the latest activity little more than 10 000 years ago.

Table 1. Some of the more important Palaeozoic-Early Mesozoic structural units. Brackets indicate subsurface units.

		Number, Fig. 1
Hodgkinson Basin	Late Silurian and Devonian	9
Broken River Embayment	Ordovician - Middle Devonian	10
Burdekin Basin	Middle Devonian - Early Carboniferous	7
Lolworth-Ravenswood Block	Cambrian-Ordovician	5
Drummond Basin	Late Devonian - Early Carboniferous	8
Strathmuir Synclinorium	Permian	11A
Anakie Inlier	Cambrian-Ordovician	6
Bowen Basin	Permian - Middle Triassic	20,(20)
Yarrol and Calliope Blocks (16); Campwyn Block (11)	Late Devonian - Middle Permian	11,16
Coastal (12), Yarraman (14), S. D'Aguilar (13A) Beenleigh (13B) and Texas Blocks (15)	Devonian - Carboniferous	12-15
N. D'Aguilar Block	Carboniferous - Early Permian	13A
Auburn and Connors Arches	Late Devonian - Early Carboniferous	17
Gympie Block	Permian - Early Triassic	18
Esk Trough	Early - Middle Triassic	19
Adavale Basin	Devonian	(28)
Cooper Basin	Late Carboniferous - Middle Triassic	(29)
Galilee Basin	Late Carboniferous - Middle Triassic	21,(21)

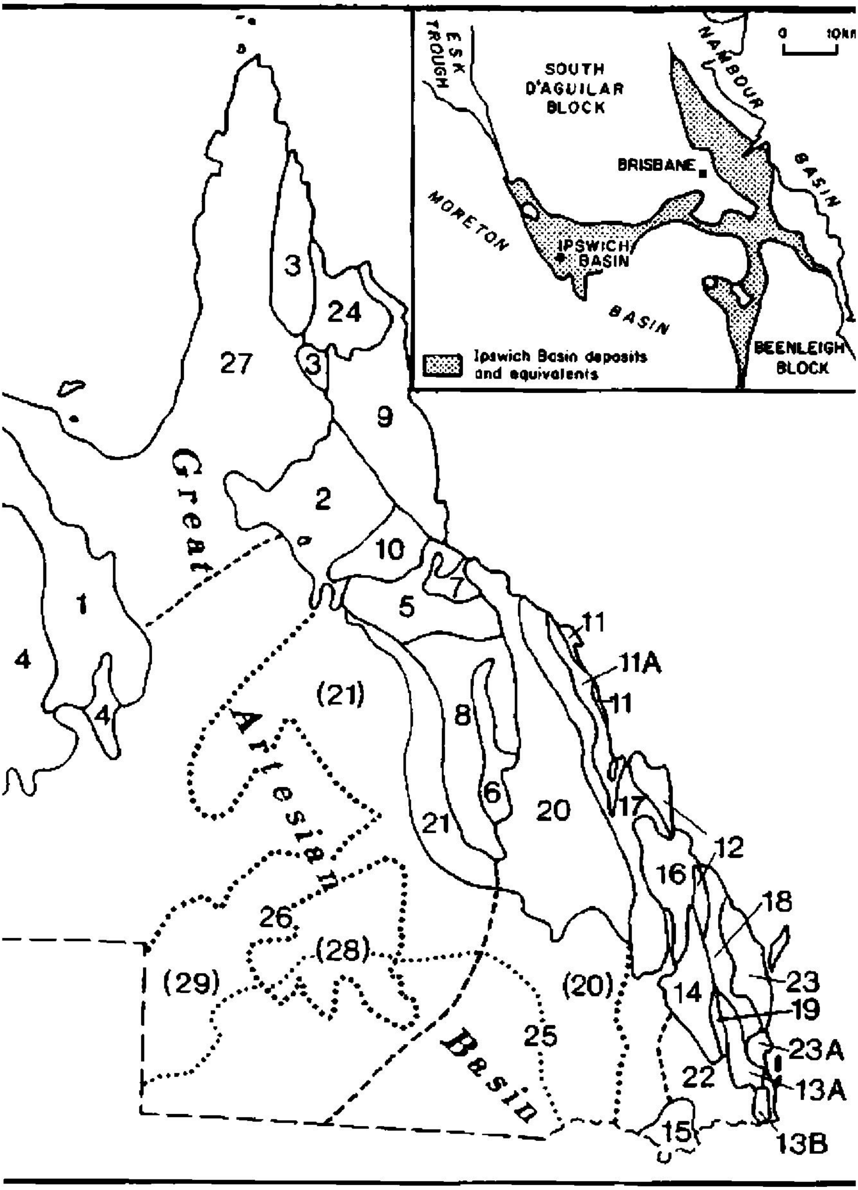


Fig. 1. Queensland sedimentary basins and stable blocks. For explanation see text and Table 1. Dotted lines are subsurface boundaries, After Fig. 3, Publ. 383, Queensl. Geol. Survey. Inset: Ipswich Basin.

GEOLOGY OF BRISBANE

Brisbane is situated at the southeast margin of the D'Aguilar Block (Fig. 1, a belt of strongly folded Palaeozoic rocks showing variable low-grade regional metamorphism. These rocks have been termed the Brisbane Metamorphics. Two major units are present: the Bunya Phyllite and the Neranleigh-Fernvale beds.

The Bunya Phyllite is well developed in the southwestern suburbs and the belt extends north-northwest through Ferny Grove to beyond Dayboro. The phyllite consists of quartz-rich layers alternating with layers of fine-grained chlorite and white mica, originating from a sedimentary sequence of shales and quartz-rich sediments. The structure is complex and the layers are parallel to a metamorphic foliation or cleavage rather than original bedding (which has been obliterated by several fold movements). When looked at closely, numerous minor folds can be seen in the phyllite: narrow v-shaped folds in quartz layers with limbs nearly parallel, small-scale crenulations, kinks, and small folds of a more open type. In the central part of the belt the foliation dips gently, but towards the margins dips are steeper, to the southwest and northeast, giving the impression of an anticlinal fold with a NNW. - SSE. axis, plunging to the south, termed the Indooroopilly Anticline (or Antiform). On the southwestern margin detailed study has shown that there are two foliations, the one with gentler dip becomes less prominent to the west where the steeper foliation is dominant, casting doubts on whether the structure should be called an antiform. The latest interpretation eliminates the need for a faulted boundary with the Neranleigh-Fernvale beds at Kenmore. The northeastern margin is along or close to a major fault known as the Normanby Fault.

The Neranleigh-Fernvale beds show much more variety in rock types than the Bunya Phyllite: slate or argillite, siltstone, greywacke and other sandy rocks (arenite), chert, and basaltic lava flows. In general, they appear to be less metamorphosed and contain less quartz veining. True bedding can be seen in many units, though it may be disrupted by earth movements to form transposition layering, to which a cleavage is often parallel. Unlike the Bunya Phyllite, second deformation structures in the Neranleigh-Fernvale beds are generally weak, but become more intense in certain areas and may cause siltstones in these beds to resemble the Bunya Phyllite.

The inner city is built on these rocks, mainly on slates and siltstones which in places are strongly cleaved. Some of the hills of Brisbane's suburbs (Mt Gravatt, Wellers Hill) are formed from resistant cherts which are interbedded as lenticular masses. Although some quartzites and sandy rocks are found close to Brisbane, the best exposures of greywacke are in the Dayboro and Beenleigh districts. Altered basaltic volcanic rocks are present close to the city (North Quay) and are found in the Jindalee, Pullenvale and Mt Nebo districts.

The age of the Neranleigh-Fernvale beds, once regarded as Silurian, is now thought to be Carboniferous and possibly Devonian, principally because of isotopic age determinations on granitic fragments in a breccia and from lightly metamorphosed sediments, both from the Beenleigh Block to the south of Brisbane. The results of this dating indicate that some of the strata are of Late

Carboniferous age, but those of the D'Aguilar Block may be older (the presence of several granitic intrusions suggests a lower level of erosion). Fossil finds from near Mt Nebo (fragments of crinoids, brachiopods and bryozoa), although not definitive, tend to confirm this age. The Bunya Phyllite is more difficult to date, and is now regarded as either the same age as, or slightly older than, the Neranleigh-Fernvale beds. Isotopic age dating indicates that these rocks were folded and regionally metamorphosed in the late Carboniferous or earliest Permian times.

Small areas of Permian or Early Triassic volcanic rocks unconformably overlie the Neranleigh-Fernvale beds near Kholo Creek, Jolly's Lookout and Mt Glorious, but there are no marine Permian rocks close to Brisbane. During this period the Brisbane district was above sea level and no further deposition occurred until late in the Triassic Period. During the Middle Triassic, intrusion of batholiths, stocks and dykes took place with the formation of the Enoggera Granite, the Samford Granodiorite and probably the Indooroopilly Intrusives (rhyolites).

The Mesozoic strata of Brisbane and suburbs are mostly horizontally bedded or very gently dipping, and thus rest unconformably on Palaeozoic rocks. They were deposited in freshwater lakes, and the contained fossils are largely plant remains (ferns, horsetails etc.). At the base of the sequence is the Brisbane Tuff, a formation which begins with scree deposits, bedded lake sediments and tuffs, followed by massive volcanic ash-flow deposits, also known as welded tuff or ignimbrite. The latter have been deposited by high-temperature gas clouds of great fluidity, and are products of violent explosive eruptions of rhyolitic magma.

The sedimentary rocks which overlie the Brisbane Tuff are shales and sandstones of Late Triassic age. The plant remains contained in the shales indicate a Triassic age but more precise dating is obtained by studying the microflora (spores and pollen). The formation immediately above the Brisbane Tuff is the Aspley Formation, mainly of sandstone and conglomerate; this and the overlying Tingalpa Formation are correlated with a part of the Ipswich Coal Measures, deposited in the Ipswich sedimentary Basin (Fig. 1, inset). The shale and coal present in the Tingalpa Formation indicate deposition in a lake or swamp, whereas the sandstone and conglomerate indicate more rapid deposition by rivers flowing into the lake, building up alluvial fans.

Above the Tingalpa Formation is a formation of sandstone and conglomerate with only minor shales, formerly known as the Moorooka Formation. It is now included in the widespread Woogaroo Subgroup, which ranges in age (palynological evidence) from latest Triassic to earliest Jurassic (Table 2), and overlies the Tingalpa Formation with slight angular discordance. This sandstone formation is found in an east-west belt in Brisbane's southern suburbs, and was deposited probably in a strait (the Brisbane Strait) between the Moreton and Nambour Basins. Rocks of similar age and type occur in the northernmost suburbs at Sandgate, at the southern extremity of the Nambour Basin. The

sequence in the Brisbane area is:

(top)	4.	Woogaroo Subgroup	∿ 180 m
	3.	Tingalpa Formation	∿ 300 m
	2.	Aspley Formation	∿ 300 m
(base)	1.	Brisbane Tuff	∿ 200 m

The Tertiary rocks of Brisbane and suburbs are in three shallow basins: one in the Kuraby-Darra-Browns Plains district, another between Wynnum and Capalaba with basalts along the coast and on some adjacent islands of Moreton Bay, and a third, between Petrie and Nudgee, with a possible extension on the Redcliffe Peninsula. The sediments comprise mudstones, siltstones, shales, sandstones, gravels, limestones, and (in the northern basin) minor oil shales and brown coals.

Basalts are interbedded with the sediments in all three basins; in the coastal belt a maximum of nearly 300 m of basalts have been penetrated in drill holes beneath sea level to the southeast of Manly.

The sequence in the southern suburbs (Darra-Kuraby) is:

Oxley Group	3.	Sunnybank Formation	38 m sandstones, conglomerate
	2.	Corinda Formation	164 m mudstones, siltstone, shale and basalt with minor limestone, conglomerate and sandstone
	1.	Darra Formation	100 m sandstone, mudstone, siltstone, conglomerate

In the Corinda Formation, basalt occurs at the top (Eight Mile Plains Basalt) and bottom (Archerfield Basalt); both these basalts have been isotopically dated (Eocene and Palaeocene respectively), confirming earlier estimates by means of palynology, and fixing the age more exactly.

In the northern suburbs, the Tertiary sediments and basalts of the Petrie Basin are not divided and are called the Petrie Formation. The rock types are similar to the Corinda Formation and include oil shale. The sediments of both the Oxley Group and the Petrie Formation were deposited in freshwater lakes, and contain dicotyledonous leaf impressions and other plant fossils, mussels, brachiopods and ostracods. Crocodile and turtle remains, fossil fish and crustacea have been reported from the Oxley Group.

Most of the Tertiary coarser sediments are poorly consolidated and the basalts are generally weathered. Some Tertiary rocks show lateritic weathering profiles.

Quaternary deposits comprise sediments along the river courses (including Pleistocene high terraces), sands of the giant sand dunes of Stradbroke and Moreton Island, and of frontal dunes and beach ridges, Quaternary coralline limestone of Moreton Bay shores and islands and various estuarine, deltaic and coastal flat deposits.

During glacial periods in the Pleistocene, sea level was much lower, and sands deposited by northerly-flowing longshore currents during interglacial periods were exposed to subaerial weathering and strong southeasterly winds,

heaping up the sands into high dunes. The rise of sea level at the end of the last glacial period covered the lower slopes of the sand masses, flooding the low area now known as Moreton Bay, and isolated the high dunes as islands. Erosion accompanying the return of the sea about 5000 to 6000 years ago to near its present level, produced steep slopes around the islands, especially along their eastern sides, but after that time, beach sands accumulated along the shore, building out towards the sea, and forming a succession of low parallel beach ridges with intervening swampy depressions.

Within Moreton Bay, recent nearshore sediments consist of up to 10 m of mud supplied by the major rivers. Farther out the mud gives place to sand deposits brought into the Bay from the longshore currents by tidal and wave action.

1. BRISBANE, NORTHERN SUBURBS (TO ASPLEY)

Features: Contrasting rock types and structures of the Late Triassic Brisbane Tuff and the Devonian-Carboniferous Neranleigh-Fernvale beds and the unconformity between them.
Route: Kangaroo Point, Windsor, Chermside West.
Maps: Fig. 2, Brisbane street maps, Brisbane 1 : 100 000 geological map..
Stop 1. Kangaroo Point cliffs. Accessible by road along the base from Dock Street, off Stanley Street, South Brisbane, to boat ramp, also by steps from River Terrace near the junction with Main Street. The wall along River Terrace above the cliffs is composed of blocks of ignimbrite of the Brisbane Tuff formation, mostly redressed material from the old quarry at Stafford.

Most specimens exhibit fragments - these are mainly from the Palaeozoic metamorphic rocks (phyllites, jasper etc.) and are usually surrounded by pale-coloured haloes (reaction zones). The ignimbrite also contains greenish igneous rocks of uncertain origin and in places shows a faint to well-marked layering resulting from the parallel orientation of elongate rock fragments and streaks of glassy pumice deformed during deposition by the weight of the overlying ash-flow. Minerals present are quartz (in bipyramidal crystals) and glassy potash feldspar. Wood fragments, carbonized, or replaced by silica and veins of chalcedony and common opal have been found in the Stafford quarry. The ignimbrite is noted for the pink, green and mauve colours produced by iron compounds and weathers brown, especially along joints. Colour banding, in brown concentric rings is also a weathering feature.

The ignimbrite in the cliffs may be examined by walking down (or up) the steps, confirming the fragmental nature and horizontal layering, and noting the joint pattern.

About 350 m from the foot of the steps, near the north end of the road, a dyke-like structure (Fig. 3A) occurs in an upward-tapering triangular zone of lighter-coloured, more altered ignimbrite. The 'dyke' is about 30 cm wide, of slightly greenish rock containing quartz fragments and weathering products. This material either fell into the fissure (a possible fault) or was squeezed up it during earth movements. The adjacent altered zone may have been caused by escaping

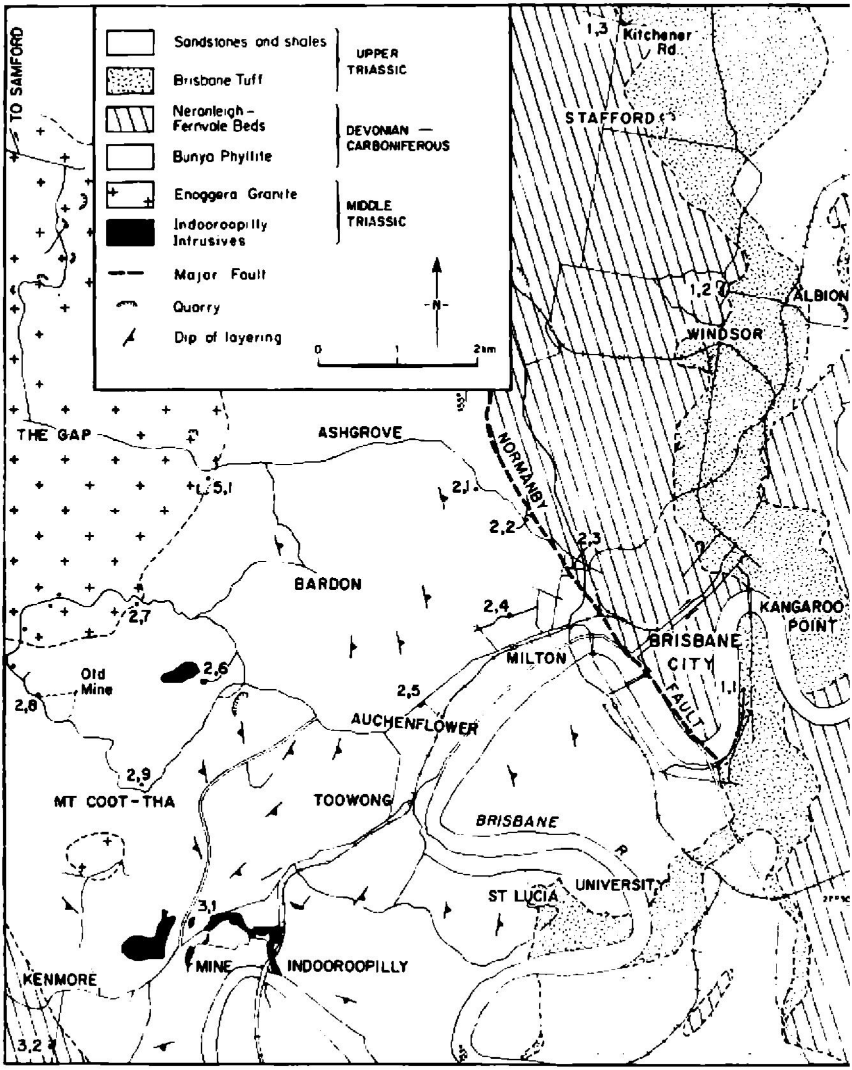


Fig. 2. Geological map of Brisbane's inner western and northern suburbs.

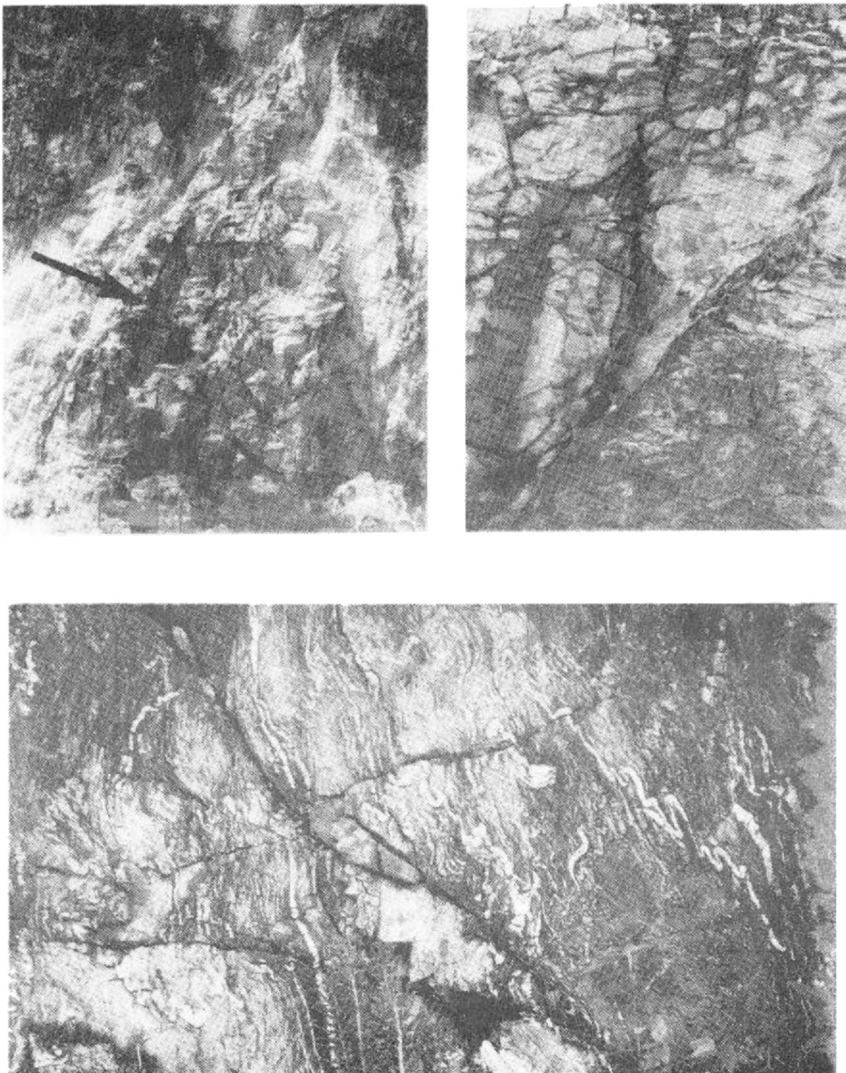


Fig. 3.A: Sedimentary dyke in Brisbane Tuff, Kangaroo Point cliffs. B: Faulted junction between Brisbane Tuff (left) and Neranleigh Fernvale beds (right), Reservoir off Lawrence Road, Chermside West. C: Bunya Phyllite, Heussler Terrace, Milton.

gases (a fumarole) or simply by percolating water into more fractured rock.
Stop 2. Old Council quarry, Lutwyche Road, Windsor, opposite Albion Road junction. At the north end of the quarry, the unconformity between Neranleigh-Fernvale beds and the Brisbane Tuff formation (Fig. 4) is exposed in the quarry wall. The older rocks, which are quartzites and phyllites transversed by quartz veins, dip northeasterly at varying, moderate angles; the Triassic rocks (breccia, shale, tuff, and ignimbrite) dip southeasterly at about 30^{o} (higher than normal).

The Palaeozoic rocks have been folded, uplifted and eroded to a rather uneven surface before deposition of the sediments and ash flows in the Late Triassic. The unconformity represents a time break of over 100 million years.

Above the surface of the unconformity, a coarse, incoherent sedimentary breccia containing fragments of the older rocks (phyllites and quartzites) is the lowermost Triassic sediment. It is interpreted as scree material on slopes of Palaeozoic rocks.

Bedded tuffs overlie the breccia, passing upwards into massive ignimbrite. Hard and soft layers of tuff alternate, the harder ones being impregnated by iron oxides, which fill curving joints in the ignimbrite above. Some carbonized and silicified wood has been found in the tuffs. The tuffs were deposited on the shores and in the shallow waters of small Triassic lakes. Jointing is complex and mostly irregular in the ignimbrite at higher stratigraphic levels except for polygonal columnar jointing with variable dip near the south end of the quarry.

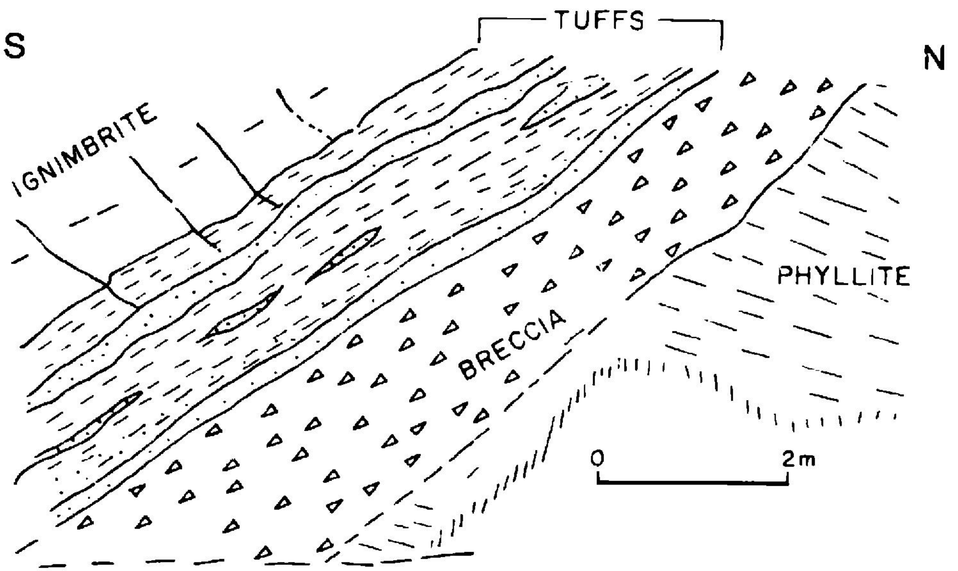


Fig. 4. Unconformity between Neranleigh-Fernvale beds, dipping towards the right, and breccia, tuff and ignimbrite of the Brisbane Tuff, dipping towards the left, Lutwyche Road, Windsor.

Stop 3. Corner of Webster and Kitchener Roads, Chermside. Another example of the unconformity seen at **Stop 2.** Brisbane Tuff formation rests unconformably on phyllites and quartzites at this point, the sequence along Kitchener Road being (from the unconformity up): a sedimentary breccia with phyllite fragments, a thin bed of mudstone or tuff with phyllite fragments; purple, green, and red-brown tuff; ignimbrite and tuff showing some bedding; then massive ignimbrite with a thin tuff layer.

Other exposures of the unconformity in the same area may be seen on Rode Road, 550 m west of the junction with Webster Road, and at the northern end of a cutting to the west of the quarry in ignimbrite south of Rode Road. The top of the ignimbrite and the overlying Triassic conglomerates and shales (Aspley Formation) are exposed on the east side of Webster Road north of Rode Road.

Stop 4. Reservoir, accessible from west end of Lawrence Road, Chermside West (Request permission from Brisbane City Council).

The cutting facing the southern wall of the reservoir has a good example of a normal fault at the eastern end (Fig. 3B), bringing Brisbane Tuff (east, downthrow side) against siliceous argillites of the Neranleigh-Fernvale beds. The unconformity between these units is exposed about 20 m northerly, dipping gently to the south. Only a thin layer of fragments (breccia) is at the base of the ignimbrite. In the Neranleigh-Fernvale beds several faults and some medium-scale folds can be seen, as well as strong jointing.

Stop 5. Corner of Graham Road and Hawbridge Street, Aspley. Mud springs occur in the Tertiary Petrie Formation along an east-west zone about 26 m long. Water enters an aquifer beneath higher ground to the west and emerges under pressure, softening the overlying shales at a structurally weak point and building up mounds of mud up to 1.5 m high.

2. BRISBANE, INNER WEST AND SOUTHWEST SUBURBS (TO MT COOT-THA)

Features: Bunya Phyllites, Neranleigh-Fernvale beds, Enoggera Granite, Indooroopilly Intrusives (rhyolite and porphyry dykes).

Route: Ithaca-Red Hill, Milton, Auchenflower, Toowong, Simpsons Road, Sir Samuel Griffiths Drive, Mt Coot-tha.

Maps: Fig. 2, street maps, Caboolture 1 : 100 000 geological map.

Stop 1. Waterworks Road, at corner of Lintern Street, Ithaca. Close to steps (X, Fig. 5A) the dominant structure in Bunya Phyllite is a steeply dipping foliation. On close examination this is seen to be parallel to the axial planes of small, tight folds (Fig. 5B). A later, more open folding is visible in some of the outcrops on Waterworks Road (Y, Fig. 5A). Quartz veins are both outlining the folds and cutting across them.

Stop 2. Proceeding east along Victoria Street, Red Hill, from the junction with Windsor Road, the Normanby Fault is crossed, with a change from Bunya Phyllite to Neranleigh-Fernvale beds (siltstones and cherts with narrow quartz veins). These beds, which form the cliff exposures on the north side of the street are structurally different from the Bunya Phyllite, and of lower metamorphic

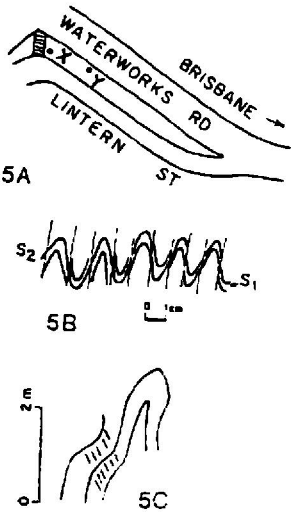


Fig. 5.A: Locality map for Excursion 2, Stop 1. B: Relation of small folds to foliation (S_2) in Bunya Phyllite. C: Folds in cherts, Excursion 2, Stop 2.

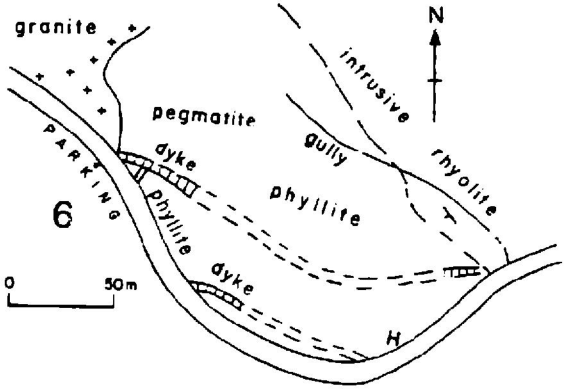


Fig. 6. Sketch map for Excursion 2, Stop 7.

grade. Tight folds may be seen in the cherts high up on the cliff near some steps (Fig. 5C) and quartz veins in siltstones under the trees.

Stop 3. Mountjoy Street, Normanby, at the top of the hill. The foliated rocks were originally basic lavas, and are now greenstones, belonging to the Neranleigh-Fernvale beds. Traces of pillow structure, much deformed, are represented by zones of small vesicles.

Stop 4. Heussler Terrace, Milton, at junction with High Street. Layering in the Bunya Phyllite dips steeply to the east. Small tight folds (Fig. 3C) outlined by quartz are intersected by later quartz veins which are also folded to a lesser extent.

Stop 5. Milton Road and Ridley Street intersection, Auchenflower. A deep road cutting exposes greenstone (formerly basic igneous rock or tuffs), then Bunya Phyllite to the south with complex structure, intruded by a fine-grained dyke, now much altered.

Continue along Milton Road towards Mt Coot-tha, past Botanic Gardens and the Council Quarry entrance (on the left) and keep straight ahead to join Simpsons Road, turning right at the top of the hill.

Stop 6. J.C. Slaughter Park, off Simpsons Road. Follow the sealed road through the park to the end (0.8 km), walk down to the creek and follow it upstream to a small dam, then up to a gully to the right. Outcrops of contact metamorphosed phyllite show folded quartz layers. Large blocks of hornfels from Mt Coot-tha quarry and granite from Ashgrove quarry have been dumped in this area. The top of the hill to the north of the parking area is composed of intrusive rhyolite, probably as a nearly horizontal layer.

Return to Simpsons Road and go straight ahead (along Sir Samuel Griffith Drive) at the next road junction.

Stop 7. Park either at 0.5 or 0.7 km past the road junction on uphill curves. The higher site is opposite the contact of Enoggera Granite (an adamellite) and hornfels derived from Bunya Phyllite (Fig. 6). A narrow pegmatite vein (much hammered) follows the contact. Nearby on the downhill side, a dipping dyke of grey quartz feldspar porphyry (dacite) shows columnar jointing at right angles to its margins; it is strongly altered and contains pyrite. Farther down the road, the phyllite appears less hornfelsed and the foliation dips gently; a weathered dyke intersects the phyllite. Around the next bend the phyllite has been locally converted to a hard, blue-grey hornfels without any igneous rocks nearby. A quartz porphyry or rhyolite intrusive is present on a steep bank farther down the road and also in the adjacent scrub-filled gully above the road. Another flat-lying dyke has intruded phyllites in the next cutting down the hill.
Stop 8. Parking area sign-posted 'Old Gold Mine', 0.5 km past Channel Nine Television Station. A walk of several hundred metres leads to an old bridge crossing a gully. A rock pile from the shafts (now water-filled holes nearby) at the far end of the bridge contains hornfels with quartz layers, stained by iron oxides from decomposing pyrite. Some brown and pink garnets have been found here in the past. A dyke of rhyolitic rock, porphyritic in feldspar, forms a bar across the creek.
Stop 9. Mt Coot-tha. From this point there are excellent views of the meanders of the Brisbane River, isolated hills and ridges representing more resistant rocks, such as Mt Gravatt (195 m). The volcanic peaks around Mt Flinders are seen to the south.

The Brisbane River valley may have been initiated in the Mesozoic Era after faulting created a gap in the Palaeozoic mountain ranges between the D'Aguilar and Beenleigh Blocks. During the Tertiary Period, the river took the place of lakes between Brisbane and Ipswich and was later entrenched during glacial periods of the Quaternary, when sea level was much lower.

Additional locality: Macquarie Street, New Farm, between Walker Avenue and Florence Street, opposite the old Dalgety's Wharf.

Shale, siltstone and minor fine-grained sandstone of the Neranleigh-Fernvale beds in this exposure have been considerably deformed by earth movements and altered by weathering. The original foliation, which may have been steeply dipping, has been refolded during a second episode, resulting in a prominent foliation, parallel to the axial planes of the later folds, striking approximately north-south, with shallow westerly dips of 10-25°.

3. BRISBANE, SOUTHWEST SUBURBS (TO UPPER BROOKFIELD)

Features: Neranleigh-Fernvale beds (including basic volcanics), Bunya Phyllite, minor rhyolitic intrusions.
Route: Indooroopilly, Kenmore, Brookfield, Upper Brookfield (about 50 km).
Maps: Fig. 7, street maps, Caboolture and Ipswich 1 : 100 000 geological maps.
Stop 1. Indooroopilly State School, Moggill Road (park in Woodville Street, or adjoining side streets). Rhyolitic dykes and irregular intrusions intrude Bunya

Phyllite at several exposures on both sides of the road. Garnets and sulphides have been reported from the rhyolite in this district and lead-zinc sulphide ore was once worked to the southeast, at Finneys Hill, in brecciated rhyolite. The mine is now used by the University of Queensland as an experimental and training mine, and is open to the public once a year, usually in September.
Stop 2. Marshall Lane, Kenmore, near Gilruth Road. Bedded cherts (Neranleigh-Fernvale beds) in the cutting exhibit minor folds.
Stop 3. Brookfield Road, 1.2 km past Kenmore shopping centre. Greywacke, with an andesitic intrusive at the eastern end of the cutting and flat-lying and vertical quartz veins at the western end. At Brookfield State School the first outcrops of volcanic rocks, weathered basic tuffs of the Neranleigh-Fernvale beds are seen, and these rocks (with lavas and breccias) continue for the next 5 km. Pillow structure indicative of submarine deposition has been found in altered basalts of this area.
Stop 4. Altered basalts with abundant fragments occur at 1.8 km past the junction with McMullen Road; at the far end of this cutting, bedded, contorted cherts appear to be faulted against the volcanic rocks.
Stop 5. At 0.65 km past **Stop 4**, prominent joint planes in sheared brecciated lavas dip towards the road. Former pillows are indicated by traces of vesicular structure (small holes in curving zones).
Stop 6. The next cutting (south side of road) shows similar rocks but with abundant calcite. A manganiferous basic dyke occurs farther along the cutting and then slates overlie the volcanic rocks.
Stop 7. 3.1 km past McMullen Road. Compacted shales, almost slates, show well-marked bedding with alternating light and dark layers dipping away from the road to the southwest.
Stop 8. 1.25 km past Upper Brookfield School and Pacey Road, reddish cherts containing radiolaria make poor outcrops at a property entrance (no. 615). Better outcrops are in the creek nearby.
Additional locality: The more northerly cuttings on the Western Freeway (southwest of Toowong Cemetery) show contact metamorphosed Bunya Phyllite, intruded by rhyolitic and andesitic dykes; some sulphides have been reported both in the phyllite and in the intrusives.

4. BRISBANE, SOUTHEAST SUBURBS (SALISBURY, MT GRAVATT)

Features: Mesozoic sedimentary rocks, Palaeozoic metamorphics, folds in chert, alluvial cave.
Route: Salisbury, Nathan, Mt Gravatt, Whites Hill.
Maps: Fig. 8, street maps, Brisbane 1 : 100 000 geological map.
Stop 1. Pentex Street, Salisbury (Fig. 9A). At the top of the rise, a cutting in sandstone overlying thinly bedded dark grey carbonaceous shale and siltstone with minor coal beds. Plant fossils have been found in white claystone interbeds. The coal-bearing shales belong to the Tingalpa Formation, and the overlying sandstone, with minor pebble bands and shale lenses forms part of the Woogaroo Subgroup. The shales can also be seen at the end of Flanders Street (north side,

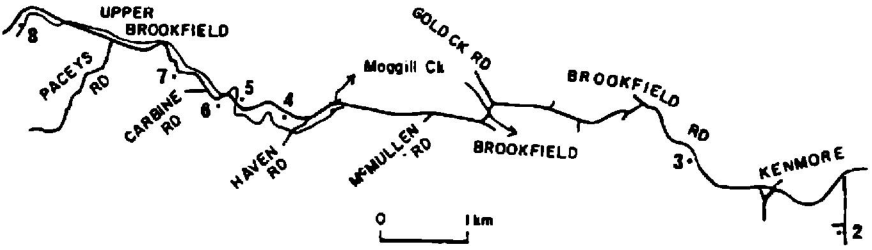


Fig. 7. Route for Excursion 3.

Stop 1A), and the sandstones, dipping southerly at low angles, make good outcrops in adjacent Toohey Forest Park.

Stop 2. Salisbury Hotel, Nathan (near junction of Fairlawn Street with Toohey Road). A large, high, excavated cliff provides an excellent example of an unconformity, in this case between deformed metasedimentary rocks (formerly well bedded black shales and grey siltstone with some thin beds of greywacke) of the Neranleigh-Fernvale beds and the overlying sub-horizontal pebbly sandstones of the Woogaroo Subgroup. The unconformity is best viewed from the front of the Mazda property (Fig. 9B) on Fairlawn Street (note steeply dipping normal fault displacing unconformity), or close up, 50 m from the top of Dellwood Street.

Stop 3. Griffith University, northern side of main ring road (stop as soon as Roundabout is seen ahead). Neranleigh-Fernvale beds at this locality, consisting of relatively undeformed shale and siltstone, are overlain unconformably by siltstone and fine-grained sandstone of the Woogaroo Subgroup. Both units have apparent dips in the same general direction, the older beds having the steeper dip.

Proceed towards Freeway but go via Klumpp Road to Logan Road, thence towards city and turn left at Shire Road.

Stop 4. Mt Gravatt Outlook Drive. Two quite different features can be seen in this area: folded Neranleigh-Fernvale bedded cherts in a cutting at the second major left-hand curve on the climb up the hill, 1.2 km from Logan Road, and a cave in eroded valley fill in the floor of a gully to the east. It is best to park 400 m downhill from the folded cherts. In the road cutting, both chevron and box-like folds are present in the cherts (Fig. 10). Their axial planes strike NNW. and dip steeply westerly.

The cave, reached by a track from the lower parking area, is floored with angular pebbles and cobbles of chert, except for a small outcrop of chert bedrock. The roof and walls are of chert fragments in a clay matrix. The cave has formed by piping, a process in which dispersion of a flocculated clay, or transport of fine-grained particles into open spaces, takes place. The deposit is a valley filling, derived from Neranleigh-Fernvale cherts.

Stop 5. Whites Hill, southeast side, off Boundary Road to the east, south of Indus Street. Neranleigh-Fernvale slates show layering dipping steeply (the rocks are fresher than those along Boundary Road to the south).

Fig. 10. Folds in bedded cherts, Mt Gravatt.

Additional localities: 1. Wellers Hill, off Marshall Road, 2.3 km NNE. of **Stop 1**: folded cherts. 2. Fitzgerald Street, east end, off Darcy Street, Norman Park. A sedimentary breccia, well-cemented, with fragments of metamorphic rocks, underlies Brisbane Tuff.

5. SAMFORD, MT NEBO, MT GLORIOUS

Features: Samford Granodiorite and its contact metamorphic zone in Palaeozoic rocks, Jollys Lookout Andesite, Tertiary basalt, dykes.
Route: Ashgrove, Samford, Mt Glorious, Mt Nebo, and return via Ashgrove (about 100 km).
Maps: Fig. 11, Caboolture 1 : 100 000 geological map.

The Samford Granodiorite pluton occupies an amphitheatre-shaped depression, partly surrounded by high ridges of contact-metamorphosed country rock. The reason for this is the difference in resistance to erosion between the relatively weak granitic rock and the tough hornfels of the contact metamorphic zone.

The Samford plutonic mass is mostly of granodiorite, with some dioritic rock south of Mt Nebo. The granodiorite has finer-grained, porphyritic and quartz-rich variants. The country rocks are Bunya Phyllite on the east and Neranleigh-Fernvale beds on the west; the junction between these runs northwesterly and is interrupted by the intrusion.

Stop 1. (May be omitted, depending on time available) Granite quarry, Waterworks Road, Ashgrove. The quarry is not being worked at the time of writing, but permission to enter should be obtained from BMG Quarries.

The quarry is in pink adamellite of the Enoggera Granite, close to the eastern margin of the intrusion. The rock varies from a microgranite with large quartz grains to a granodiorite (which occurs in xenoliths and in other parts of the intrusion). Thin dykes of aplite and larger dykes of grey-green altered quartz-feldspar porphyry or dacite (similar to the one mentioned at **Stop 7, Excursion 2**) can be seen, and many secondary minerals including calcite, epidote, chlorite, and laumontite (a zeolite, in pink-white radiating crystals) have been reported as well as the sulphides pyrite and molybdenite, and tourmaline, of high temperature origin. The contact with hornfelsed Bunya Phyllite is exposed on higher benches at the southeast margin of the quarry.

Continue along Waterworks Road and turn right into Settlement Road. After passing a curving hilly section of the road, quarries are seen on the right in weathered granite with large, fresher boulders. Turn left into Samford Road and continue on past Ferny Grove. Cuttings on the right on the edge of the State Forest show Bunya Phyllite with one or two rhyolite dykes exposed.

Turn left off the Samford Road either at the top of a long hill 4 km from Ferny Grove on to a gravel road, or several km farther on at a church (onto a sealed road) to Upper Camp Mountain Road and follow it to Betts Road. Decomposed granite with narrow quartz or aplite veins is seen along both roads, but the most interesting cuttings (**Stops 2-4**) are those in which granite has intruded hornfelsed Bunya Phyllite just before the Betts Road junction and 350 m and 500 m past this junction. In the first cutting, the granite is in a narrow dyke and is rather weathered. Both the hornfels and the granite have been intersected by narrow, white, carbonate veins. The next cutting shows a fresher granitic dyke and **Stop 4** shows wide and irregular intrusions into veined hornfels.

Return to Samford Road, continue on towards Mt Glorious, passing over the Samford Granodiorite to the beginning of the steep ascent 6.8 km past Samford. The contact is not well exposed here, but boulders of hornfels occur in and near the creek at the first causeway.

Stop 5. 1.6 km farther on, a light-coloured rhyolite dyke has intruded grey and black siltstones. The dyke is steeply dipping, slightly banded, and shows some quartz phenocrysts.

Stop 6. Massive outcrops of a greywacke conglomerate are seen 0.55 km past **Stop 5**. These rocks have steep dip, and belong to the Neranleigh-Fernvale beds.

Stop 7. 0.45 km past **Stop 6**. Steeply dipping slates of the same beds have been involved in landslides at this point.

Continue up the hill to a T-junction and turn right.

Stop 8. Mt Glorious Lookout. Tertiary basalt, of which the higher land is composed, may be seen near the lookout, in a weathered condition. Fresh basalt occurs in boulders on the west side of the road 0.5 km from the lookout, on the return trip. The basalt has been dated at 22 million years (Early Miocene).

Stop 9. Basalt dykes, possible feeders to the basalt flows, have intruded slates

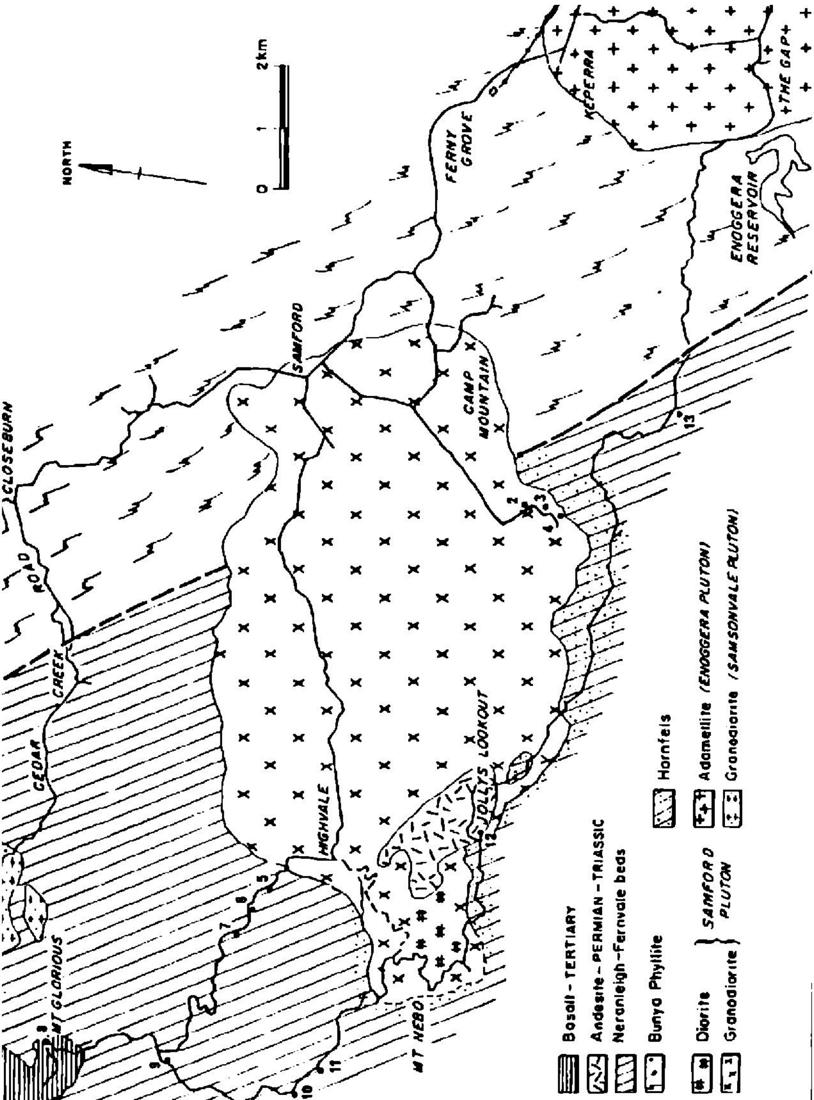


Fig. 11. Geological map of the Samford-Mt Glorious district.

200 m past the T-junction. Both are highly weathered.

Stop 10. Just less than 3 km from the T-junction, the Neranleigh-Fernvale beds include dark shales or claystones (argillites) and coarser, sandy rocks containing small, spherical particles (oolites). Sand-sized fragments of bryozoa, brachiopods and crinoid stem plates have been found here, in agreement with a radiometric age of Early Carboniferous obtained from similar beds in the Beenleigh Block.

Stop 11. About 300-350 m farther along the road, in a cutting on the right, the beds are much fresher and harder because of contact metamorphism, presumably by diorite, which is seen in boulders 2.4 km farther on (left hand side of road before junction with the old road to Samford). The same rock outcrops to Mt Nebo store and beyond, but the road is narrow and there are few safe stopping places.

Stop 12. Jollys Lookout. The hill is composed of andesite of probable Permian-Triassic age, and has been intruded by the Samford Granodiorite. The best exposures are along the narrow road, 250-400 m on the Brisbane side of the entrance road, where the rock is a breccia, containing many fine-grained xenoliths. Granodiorite outcrops from 2.2 km to 2.5 km past Jollys Lookout entrance, with hornfels farther down the road. Some contains cordierite, showing as spots on weathered surfaces. The contact rocks give place to more normal Neranleigh-Fernvale beds after 8 km from Jollys Lookout.

Stop 13. At the junction with a forestry road (on the right) 1.1 km after McAfees Lookout. Brownish, weathered greywacke is exposed in a gutter along the main road and 100 m farther on, argillites and cherts (a level area) overlie basic volcanics (downhill slope). Phyllites (of the Bunya Phyllite) are exposed at the turnoff to Bellbird Grove; these have been intruded by a thick near-vertical quartz porphyry (rhyolite) dyke 3.3 km farther on, near Box no. 70. The dyke is transverse to the road and shows upper and lower contacts. It contains much pyrite.

Additional localities: 1. McLean Road South, off Camp Mountain Road, for a granite dyke through hornfels (at 0.9 km from junction), and a grey andesitic dyke through slaty rocks 0.7 km farther on, in a narrow cutting.

2. Cedar Creek Road. 1 km west of the road junction near Closeburn, on the road to Cedar Creek. Bunya Phyllite in a cutting on a sharp bend shows intensely deformed quartz layers. These dip steeply at the south end, and are faulted at the north end of the cutting. Bunya Phyllite continues to Gordons Road; over the next 0.8 km, Neranleigh-Fernvale metamorphics are not easy to distinguish from Bunya Phyllite, except where they include bedded cherts. Black slates occur farther on, not far from the granodiorite contact. A gabbro pluton has invaded Neranleigh-Fernvale metasediments and lavas in the headwater region of Cedar Creek, about 1.6 km up the creek from the end of the road. At the time of writing, access to this area is permitted only at weekends.

Note: In Brisbane Forest Park some of the geological features are signposted and there is a geological exhibit at Jollys Lookout.

6. SANDGATE, REDCLIFFE, DECEPTION BAY

Features: Local intense folding in Triassic sedimentary rocks, laterite, altered Tertiary basalt, Quaternary shell beds.
Route: Shorncliffe, Sandgate, Brighton, Redcliffe, Deception Bay (about 80 km).
Maps: Fig. 12, Brisbane 1 : 100 000 geological map.
Stop 1. The Shorncliffe section. Access from Shorncliffe via Alpass Parade. Commencing near the jetty there are good exposures in the cliffs and on the rock platform (low tide only) of Triassic sedimentary rocks assigned to the Woogaroo Subgroup (palynological evidence).

A low-angle fault crosses the cliff at its southern end and follows the outer edge of the rock platform. Below the fault plane coarse clastic rocks (conglomerate, breccia, grit) contain fragments of quartz, phyllite, chert, etc., derived from the Neranleigh-Fernvale beds and Bunya Phyllite. These sedimentary beds are thought to be close to the base of the Triassic sequence.

Above the fault plane two prominent sandstone beds each 1.5-3 m thick are separated by 3-4.5 m of carbonaceous shales with abundant plant remains. Species of *Coniopteris, Dicroidium, Neocalamites,* and *Cladophlebis* have been recorded. Higher up, carbonaceous and silty shales alternate with sandstone.

The attitude of these overlying beds is conformable with that of the fault, the dip varying from 30 to 60° close to the fault and decreasing upwards. Beneath the fault there is a highly contorted zone on the rock platform where minor folds are overturned (Fig. 13A) towards the northeast or north-northeast. Disharmonic folds occur in sandstones above the fault.

These structures have been interpreted as the result of gravitational sliding of soft sediments, followed by a compressive movement causing the buckling of the originally flat-lying slide into a steep syncline, accounting for the curving strike of the fault plane. Steep dips are also visible in the sandstones along the cliffs west of the Sandgate pier, indicating a fault (mapped from here westerly through Sandgate).

The cliff line continues inland towards Sandgate shopping centre, thence northwesterly along Brighton Road and Brighton Terrace, parallel to the present shore. It represents a former position of the coastline, when sea level was slightly higher.

North of the fault through Sandgate, the Mesozoic strata are classed as Landsborough Sandstone, which is thought to comprise equivalents of both Woogaroo Subgroup and the overlying Marburg Formation of the Moreton Basin.

Stop 2. A good exposure of soft, cross-bedded sandstones (Landsborough Sandstone) at the western end of 22nd Avenue. Pebble beds, fossil wood, and zonal weathering may be seen in these rocks. In the northwest corner of the quarry, a weakly-developed lateritic profile is present.
Stop 3. Apex Park, Woody Point. A lateritic profile is exposed in the cliffs on the south side, showing laterite passing downwards through a mottled zone into an indistinct pallid zone partly covered by fill.

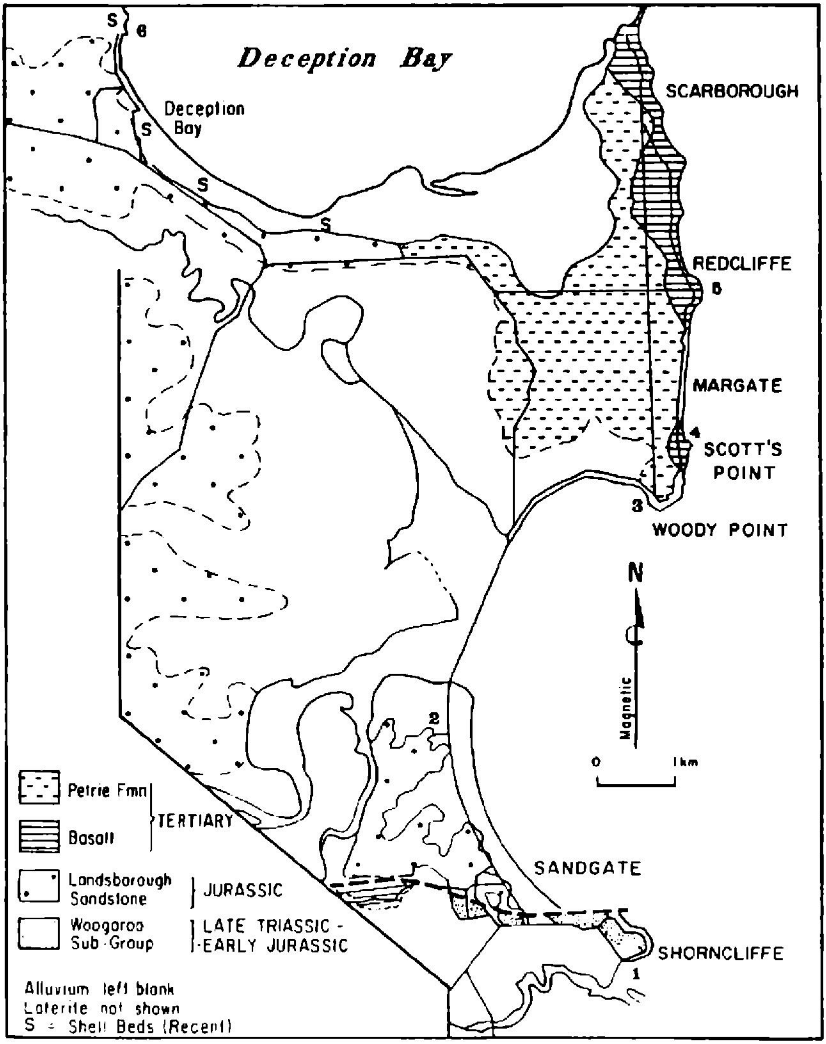


Fig. 12. Geological map of the Sandgate district.

Fig. 13.A: Fold in sandstone on rock platform, Shorncliffe. B: Concentric and linear structures, Deception Bay.

Stop 4. Scotts Point, at the south end of Margate Beach, shows highly altered (leached) basalt, probably of Early Tertiary age, with chalcedony in veins and amygdules.
Stop 5. Redcliffe, at the northern extremity of Margate Beach. Outcrops of laterite, derived from basalt, are best seen along the shoreline at low tide. Small-scale cavernous weathering is exhibited.
Stop 6. Deception Bay. From the township the shoreline is followed north from the kiosk for 1.3 km to a rock platform of Landsborough Sandstone. At this locality there are remarkable concentric and linear structures (Fig. 13B) formed by diffusion of iron-bearing solutions through the porous sandstone, and limonite deposition along joints. Fossil wood is common and there are some pebble beds in the sandstone. Overlying the rock platform, above the present high tide level, a shell bed which consists largely of shell of *Anadara trapezia* (Sydney cockle) and *Pyrazus ebeninus* (mud whelk) was partly destroyed by the building of laboratories and the rest of the exposure was hidden by a sea wall.

At other places (Fig. 12) along the coast of Deception Bay shell beds are up to 2 m above present tidal levels. Radiocarbon dating indicates ages of between 1000 and 1500 years for these deposits. Some of the coarser shell beds may be the result of storm waves; if this is so it indicates that the mangroves have become established since their formation, as storm beaches would not occur under present conditions.

7. NORTH STRADBROKE ISLAND

Features: Quaternary sand deposits on a basement of Mesozoic sandstone and rhyolite.
Maps: Fig. 14, Amity and Dunwich (Special) 1 : 25 000 maps.

Stradbroke Island was separated into two islands in 1898 by erosion at the tidal channel of Jumpinpin. Essentially, the two parts are Quaternary sand islands with only small areas of basement rock exposed.

Most of North Stradbroke Island is formed of high fixed dunes of parabolic or 'blow-out' type, with fringing low strand plains characterized by beach ridges and swamps. The junction of strand plains with high dunes is marked by steep escarpments formed by marine erosion. The old shoreline was abandoned about 6000-5000 years ago, in post-glacial (Holocene) time. The high dunes were formed in the Pleistocene Period, but estimates of the age of their commencement vary up to over 400 000 years before present. Several dune sand units with one coral-bearing horizon have been recognized within the Pleistocene deposits. As on Fraser Island and Cooloola, mapping is based primarily on airphoto interpretation, with field inspection. Particular notice is taken of the depth of leaching to the subsurface B-horizon, since the oldest units are the most deeply leached.

Some of the lakes and swamps (e.g. Blue Lake and Eighteen Mile Swamp) occur in low lying areas where the water table intersects the surface, others, such as Brown Lake are 'perched' in depressions above the level of the regional

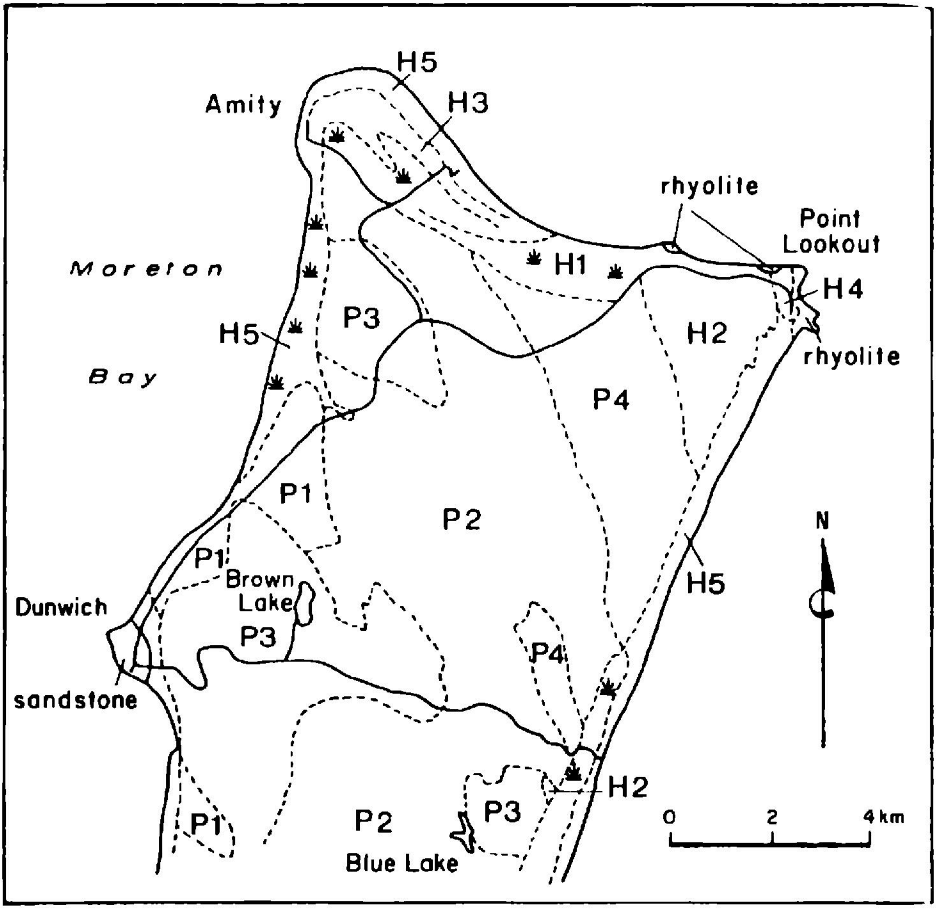


Fig. 14. Map of north end of N. Stradbroke Is., showing Pleistocene (P) and Holocene (H) dune systems, latest have highest numbers.

water table, and develop where an impermeable layer of clay or organic debris covers the floor of the depression.

North Stradbroke Island is accessible by vehicular ferry from Cleveland or Redland Bay to Dunwich. From Dunwich take the sealed road to the east, across the island to the ocean beach **(Stop 1)**. The end of the trafficable road is on the eastern margin of Eighteen Mile Swamp, near the northern end. A good view of the escarpment or old sea cliff is obtained from this point.

Stop 2. Brown Lake (see above). Return to Dunwich and travel towards Point Lookout.

Stop 3. Myora Springs. A substantial flow of water from the sand mass runs into Moreton Bay. Note rain forest, Aboriginal kitchen midden, and mangrove vegetation on mud flats. Holocene corals may be seen at low water mark, 500 m or more across the mud flats.

Stop 4. Rocky Point, old quarry. Rhyolite of Triassic or Jurassic age, showing flow banding, hematite 'clots' and phenocrysts of quartz and potash feldspar, dips steeply seaward. The same rock, with gentler dips and increasing brecciation to the east, outcrops around the coast to **Stop 5**, Point Lookout (follow tracks).

Follow sealed road back towards Dunwich taking sealed road towards Flinders Beach and Amity Point.

Stop 6. At road intersection 2 km ESE. of Amity, an excavation in sand shows the iron and humic-rich B horizon.

Stop 7. At Amity Point, the southwesterly-flowing current through South Passage (between North Stradbroke and Moreton Islands) has eroded the shoreline. Building of a groyne has caused increased erosion to the southwest.

Stop 8. East of the road to Flinders Beach. A rough track to the southeast, branching off near the road end, parallels the beach ridges, which can be examined by making a traverse at right angles to the track (towards the beach). Return to Dunwich.

Stop 9. A cliff section through Triassic-Jurassic (Woogaroo Subgroup) sandstones can be viewed near the ferry terminal. At the top is a layer of laterite, seen in fallen blocks. The sandstone shows well-marked zonal weathering and layers of ironstone, some with reniform (kidney-shaped) surfaces.

GEOLOGY OF THE IPSWICH DISTRICT AND AREAS TO THE SOUTH

The oldest rocks in this district belong to the Neranleigh-Fernvale beds at the southern extremity of the D'Aguilar Block. They are mainly steeply dipping quartzites, cherts and siltstones with some basic volcanics, forming hilly country to the north of the Brisbane River. Near Pine Mountain they have been intruded by serpentinite, which was probably emplaced at the time of folding (late Carboniferous) or in the Permian or Middle Triassic.

The Late Permian or Early Triassic Brookfield Volcanics rest unconformably on these rocks, making a small rather dissected plateau north of Mt Crosby. They comprise flat-lying rhyolite and andesite flows and pyroclastics; on their southern margin they have been intruded by the Karana (formerly Kholo Creek) Quartz Diorite, a small intrusive mass of Triassic age.

To the south of the D'Aguilar Block, the Late Triassic Ipswich Coal Measures, deposits in the Ipswich Basin, unconformably overlie the Neranleigh-Fernvale beds. The lower formations (Table 2), which constitute the Kholo Subgroup, are in an east-west belt between Pine Mountain and Mt Crosby. The basal breccias are interpreted as scree deposits from the steep hills of the older rocks. There was some early volcanic activity (Weir Basalt and Sugars Basalt), and the Hector Tuff, higher in the sequence, may be equivalent to the Brisbane Tuff. The remaining interbedded formations are mostly conglomerate and sandstone, derived largely from the the D'Aguilar Block.

The upper part of the Coal Measures, termed the Brassal Subgroup, contains productive coal seams, and is divisible into three formations: the Tivoli Formation to the north of Ipswich and along the bypass, and the Cooneana and Blackstone Formations mainly to the south of the railway line. The Tivoli Formation is probably equivalent to the Tingalpa Formation of Brisbane's eastern suburbs.

The Bundamba Group, of Late Triassic and Early Jurassic age, rests with slight unconformity on the Ipswich Coal Measures. Formations in the Group are shown in Table 2. The lower three constitute the Woogaroo Subgroup. These and the overlying Jurassic Walloon Coal Measures are deposits of the Moreton Basin, which was much more extensive than the earlier Ipswich Basin and joined with the Great Artesian Basin west of Toowoomba (Fig. 1) and with the Clarence Basin of northern New South Wales.

During the time break indicated by the slight unconformity between the Ipswich and Moreton Basins, the earlier strata were uplifted and tilted, and granitic and other quartzose rocks were exposed; fragments of these were carried by streams into the new basin, resulting in the conglomerate and coarse-grained quartz sandstone of the Woogaroo Subgroup. To the west and northwest of Ipswich these rocks are known as the Helidon Sandstone.

Later sediments from different sources gave rise to calcareous and lithic (rock fragment) sandstones, fine-grained sediments and coal, as the activity of the streams decreased and the lakes filled with sediment and vegetation.

Folding of the Mesozoic rocks is mostly gentle with widely spaced fold axes.

Table 2. Correlation of Late Triassic and Jurassic formations in the Ipswich-Brisbane-Nambour district

		Ipswich		Brisbane	Nambour Basin
JURASSIC		Walloon Coal Measures			
		Marburg Formation	Bundamba Group		Landsborough Sandstone
		Ripley Road Sandstone	Woogaroo Subgroup, Bundamba Group		Landsborough Sandstone
LATE TRIASSIC		Raceview Formation	Woogaroo Subgroup, Bundamba Group	former Moorooka Formation	Landsborough Sandstone
		Aberdare Conglomerate	Woogaroo Subgroup, Bundamba Group		North Arm Volcanics
	IPSWICH COAL MEASURES: BRASSALL SUBGROUP	Blackstone Formation		Tingalpa Formation	
		Tivoli Formation		Aspley Formation	
	IPSWICH COAL MEASURES: KHOLO SUBGROUP	Cribb Conglomerate			
		Hector Tuff		Brisbane Tuff	
		Colleges Conglomerate			
		Mt Crosby Formation			
		Blackwall Breccia ‖ Weir Basalt ‖ Sugars Basalt			

but along a NNW-SSE. line through Ipswich they dip steeply in a westerly direction and are faulted along the strike. This zone of steeper dips and faults (a faulted monocline) is termed the West Ipswich Structure.

Tertiary freshwater sediments and basaltic lava flows occur in scattered outliers, unconformably overlying the Mesozoic rocks; the most prominent development is of Eocene age at Ipswich and Redbank Plains. These strata, known as the Booval Group, have a maximum thickness of over 335 m, much of which consists of basalt flows and limestones of the Silkstone Formation. The basalt at Bundamba has been dated isotopically as Eocene, and the underlying Redbank Plains Formation (mostly mudstone, claystone and shale) is probably Eocene too. It contains fossil fish, ostracods, insect and reptilian remains, as well as

abundant plant remains. A belt of dolomitic limestones and basalts, probabl equivalent to the Silkstone Formation, forms Limestone Ridges, south of Pea Crossing.

Basalts from Mount Walker Creek and Jebrapilly are older, having bee isotopically dated as Palaeocene, but others, making up the hills north of Ros wood and Grandchester are younger (Oligocene) and may have once been cor tinuous with the basalts of the Main and Mistake Ranges to the southwes

The group of volcanic plugs centred on Flinders Peak and the basic intru ives near Limestone Ridges range from Oligocene to Miocene age. The preser height of the plugs, well above Tertiary deposits of the valley floor to the wes suggests that the upper parts of the plugs were above the level of the surroundin country at the time of eruption. The youngest igneous activity recorded in th area is represented by the trachyte of Redbank Plains, isotopically dated a 16 m.y. (million years).

8. DINMORE, IPSWICH

Features: Ipswich Coal Measures, Tertiary sediments and volcanics.
Route: Dinmore, Ipswich, Redbank Plains (about 90 km).
Maps: Fig. 15, Ipswich 1 : 100 000 geological map.
Stop 1. Redbank bypass, main Brisbane-Ipswich Road, cutting on west side c overhead bridge. Sandstones and shales of the Raceview Formation (part of th Woogaroo Subgroup) are cut by a reverse fault, with associated minor folds o the north side of the cutting (Fig. 16).

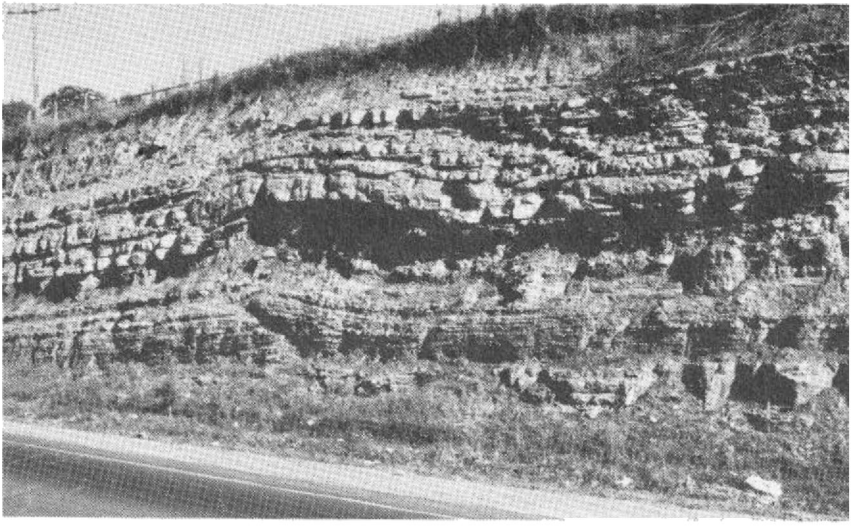


Fig. 16. Minor fault and folds in Late Triassic sandstones and shales, Redbank.

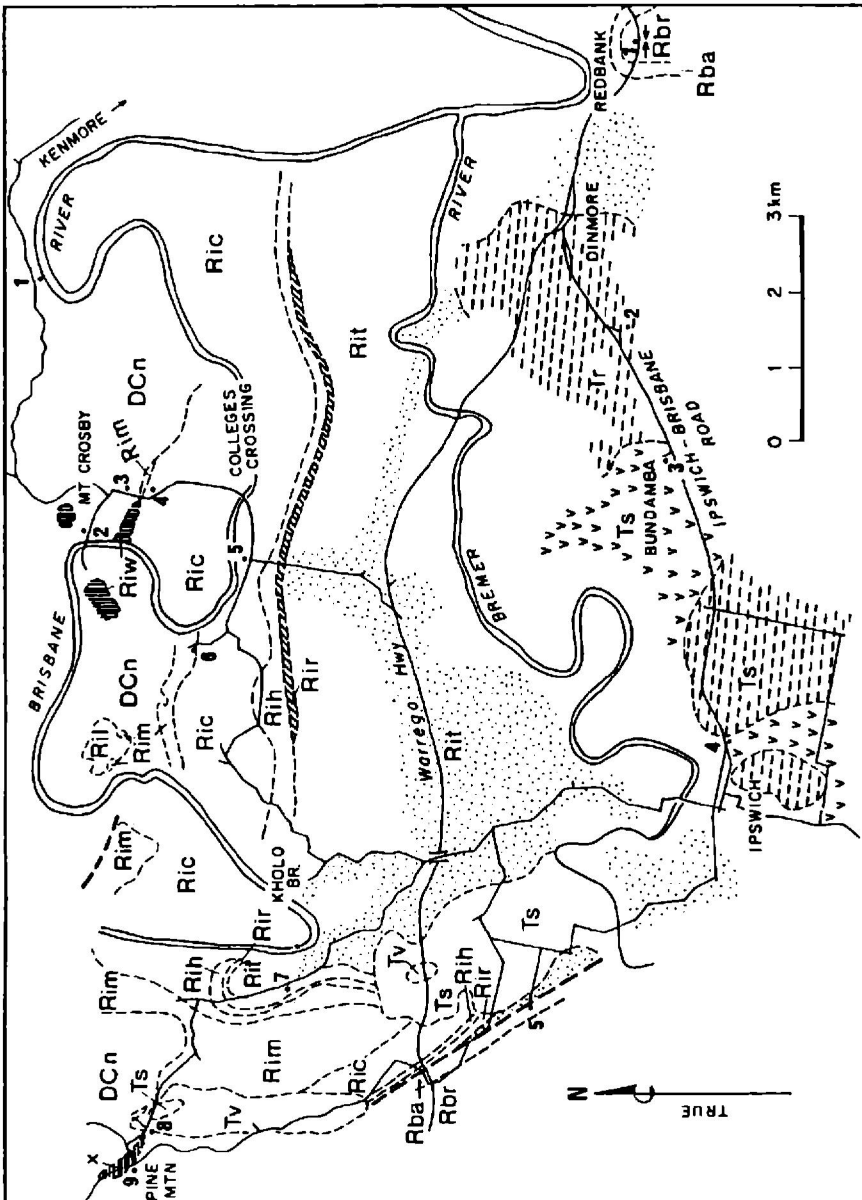


Fig.15. Geological map of the Ipswich Pine Mtn district. DCn: Neranleigh-Fernvale beds; X: Serpentinite; Riw: Weir Basalt; Ril: Blackwall Breccia; Rim: Mt. Crosby Fmn; Ric: Colleges Conglomerate; Rih: Hector Tuff; Rir: Cribb Conglomerate; Rit: Tivoli Fmn; Rba: Aberdare Conglomerate; Rbr: Raceview Fmn; Tr: Redbank Plains Fmn; Ts: Silkstone Fmn and Tertiary sediments; Tv: Early Tertiary basalt.

Stop 2. 0.8 km past Dinmore, turn left into Robert Street. At a right bend in the street, a track to the left leads to power lines, near which there are several excavations in Tertiary clay (Redbank Plains Formation), some of which (e.g. 50 m south of power line towers) shows dicotyledonous leaf impressions, and Triassic Blackstone Formation (southerly from power line towers) with *Dicroidium, Taeniopteris, Gingko, Calamites* and *Xylopteris*. Loose blocks of shale from coal mine rock waste heaps farther south also yield fossil plants.

Stop 3. Old basalt quarry, Bundamba. Turn right into Byrne Street from Brisbane-Ipswich Road, under railway, then left to 'Park and Ride'. The basalt belongs to the Silkstone Formation (Eocene); it shows spheroidal weathering and carbonate veins in weathered sections. The fresh, coarser grained basalt consists of plagioclase and pyroxene.

Stop 4. Limestone Hill, Queens Park, south side of the Brisbane-Ipswich Road. Interbedding of basalt and limestone of the Silkstone Formation is shown by alternation of these rocks between the road and Limestone Hill. The basalt is weathered and does not outcrop well, but can be recognized on the slopes leading to the two limestone ridges.

The limestone is magnesian and has been formed from weathering products of basalt, deposited in freshwater lakes on the basalt surface during intervals in volcanic activity. The only fossil found in the limestone is the small gastropod, *Planorbis*. The limestones have been strongly silicified, and are veined by chalcedony and fine-grained quartz. Some attractive breccias, caused by shattering of the limestone and subsequent recementing by silica, can be seen in walls near the road. The steep dip of the limestones and interbedded basalts is localized.

Stop 5. Quarry, Haig Street, Brassall. This site is close to the West Ipswich Fault, which strikes NNW.-SSE. Strata in this quarry dip steeply west; the eastern wall of the quarry is a dip slope surfaced by a thin shale bed containing plant remains, and Aberdare Conglomerate makes up the western side of the quarry.

The return trip may be made via the Ipswich bypass and either Mt Crosby (Excursion 9) or the Brisbane Road.

9. MT CROSBY, PINE MOUNTAIN

Features: Ipswich Coal Measures (Kholo Subgroup), serpentinite, Palaeozoic metamorphics, Tertiary and Triassic basalts.

Route: Outwards via Kenmore to Mt Crosby, thence to Pine Mountain via Warrego Highway or by minor road (about 110 km).

Maps: Fig. 15, Ipswich 1 : 100 000 geological map.

Stop 1. At the top of a steep hill on the Mt Crosby Road, junction with Wattle Street. View south across the Brisbane River towards Flinders Peak and other volcanic mountains of Tertiary age. The stop is on weathered Palaeozoic basaltic volcanics of the Neranleigh-Fernvale beds, on the southern margin of the D'Aguilar Block.

Stop 2. Mt Crosby weir. Neranleigh-Fernvale siltstones outcrop at water level, whereas the hill opposite the picnic area is formed from Triassic Weir Basalt, overlying the Palaeozoic rocks unconformably. Return to Mt Crosby Road and

continue along it towards Colledges Crossing for 0.3 km past the post office. **Stop 3.** Cuttings past Powells Road intersection show bedded cherts and slates of the Neranleigh-Fernvale beds, much folded and faulted. Near the bottom of the hill, thick, massive chert beds are interlayered with greenish altered volcanics. **Stop 4.** The next cuttings to the south show Triassic Mt Crosby Formation breccia and sandstone with overlying conglomerate. Several small faults are well displayed. Past Colledges Crossing, conglomerate forms cliffs along the south side of the road. Park at the top of the hill at a road junction (**Stop 5**) to examine this formation (Colleges Conglomerate) and look at the varied lithology in the pebbles (chert, jasper, quartzite from the metamorphics and various granites and porphyries).

From **Stop 5** take the minor road west and northwest for 2.3 km to a crossing of a pipeline (**Stop 6**), where a section through the Mt Crosby Formation (conglomerate grading upwards through coarse to fine sandstone and green to buff shales) can be seen in a cutting along the pipeline to the southwest. Plant remains and rarely, fossil insects, have been found in the shales.

Return to **Stop 5** and proceed to Pine Mountain Road via the Warrego Highway (Ipswich bypass) or return along the road towards **Stop 5** for about 0.5 km and turn right along a gravel road which goes mainly southwest and west over Colleges Conglomerate and the overlying Hector Tuff, then turn left onto a sealed road southeast of Kholo Bridge. About 1.2 km farther on, turn right at the next road junction, taking the minor road to the northwest. Stop after 2.7 km at the one lane bridge over Coal Creek (**Stop 7**) to view the Waterworks Coal Seam in a gully on the right.

The road follows the western limb of a south-plunging syncline and passes over pebbly sandstones and shales of the Tivoli Formation with moderately steep dips to the east, then conglomerate and tuff of the Kholo Subgroup. Turn left 1.4 km after **Stop 7**, then right after another 0.7 km. At the top of a hill, Eocene basalt, associated with limestone, is crossed. Shortly after this, at a lane intersection, (**Stop 8**), actinolite rock and common opal have been found near the boundary with serpentinite and overlying basalt up the lane to the northeast. Silcrete occurs beneath basalt on an intersecting lane to the right; it has been formed by silicification of Tertiary sands. From **Stop 8** continue on, turning west at a T-junction to Pine Mountain Hall (**Stop 9**).

Stop 9. On a serpentinite inlier, probably with a faulted margins. Both schistose and massive serpentinite occur, but accessible exposures are limited to roadsides. The best exposure (of schistose type) is on the road to the north of the Hall; weathered serpentinite and carbonate veins are seen on the road to the east of the Hall.

10. KALBAR - BOONAH DISTRICT

Features: Walloon Coal Measures, minor intrusions, Tertiary limestone and basalt.

Route: Ipswich, Harrisville, Waraperta, Kalbar, Moogerah Dam, Mt Alford, Mt French, return via Peak Crossing (about 200 km.)

Maps: Fig. 17, Ipswich 1 : 100 000 geological map, Mt Lindsay 1 : 100 000 map.

The sedimentary rocks in this district belong to the Walloon Coal Measures, a formation of brown to green mudstones, buff, cream, or grey sandstones, with some siltstones, shales, and thin coal seams. The mudstones contain plant remains including *Cladophlebis, Taeniopteris, Osmundacaulis,* and *Brachyphyllum.* Fossil wood is present in some of the sandstones.

Most of the sandstones are lithic and many are calcareous, especially the light grey types. Thin beds of limestone, including some showing cone-in-cone structure, are known.

The coal measures have been intruded by numerous minor intrusions - sills, dykes, and stocks, ranging from trachyte to microsyenite, dolerite, and teschenite. Contact metamorphic effects are usually very slight.

The coal measures occupy a synclinal structure between anticlinal structures to the east (exposing Bundamba Group sandstones) and the Main Range to the west, and are dipping gently or are horizontal (Fig. 20).

Stop 1. Small quarry, west side of road, 1.6 km south of Wilsons Plains. The rock is a dark doleritic rock but contains alkali feldspar and is a microsyenite or micromonzonite. In most other places this rock is weathered to a brown colour and cannot be named precisely. Similar rocks make up low hills at Kengoon and Obum Obum, to the south.
Stop 2. On the Munbilla-Milbong Road, 0.5 km east of the Peak Crossing-Kalbar Road, a typical calcareous sandstone of the Walloon Coal Measures outcrops.
Stop 3. Moogerah Dam. Mt Edwards, a domical intrusion of microsyenite (paler, even when fresh, than the rock at **Stop 1**) has been incised by Reynolds Creek, presumed to be a superimposed stream (was once in softer rocks above the intrusion, and eroded a gorge through the harder rocks). Outcrops of microsyenite may be seen along the road leading to the kiosk and picnic area, beside the dam spillway, and on the western abutment.

Return to the road leading to Mt Alford and Boonah turning left (east) at intersection with road from Moogerah and Croftby.
Stop 4. Near base of first hill, Walloon Coal Measures shales and sandstones are exposed in a cutting (left), intruded by two rhyolitic intrusions and a basic dyke, and cut by a fault. Crystalline gypsum has been found here in veins.
Stop 5. At the crest of the hill, flat-lying rhyolite as a sill-intrusion extends north across the road from an outer ring dyke of the Mt Alford Ring-Complex. The ring-dykes stand out as scrub-covered, narrow zones of outcrops and boulders to the south, on the flanks of the highest hill (Fig. 18). The middle upper part of the hill consists of microdiorite and granophyre of the central boss, and this is capped by brecciated andesite.

Plant fossils have been obtained from Walloon shales beneath the rhyolite, at a point where the downhill slope of the road begins to increase.
Stop 6. Plack Pinch rest area, past Bunjurgen. The wooded ridge is composed of intrusive trachyrhyolite, occurring near the road as boulders at the northern edge of the wooded area. Walloon Coal Measures shales and sandstones are exposed in cuttings (road too narrow for parking).

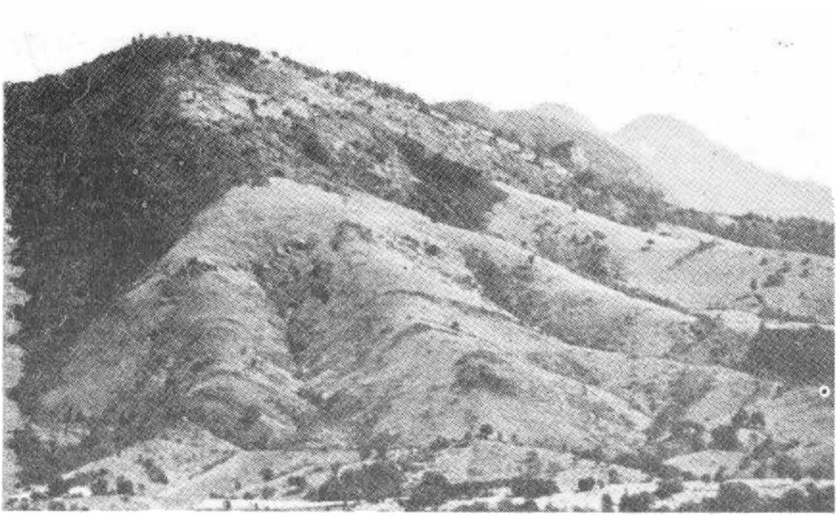


Fig. 18. The 'Northeast Peak' of the Mt Alford ring-complex. Lines of scrub on the lower slopes are the outcrops of steeply dipping ring-dykes.

Stop 7. Mt French (National Park), via a road to the west from Dugandan Hotel. Mt French is a flat-topped, stepped mass of white rhyolite with small phenocrysts. It appears to be a compound sill, as the lower part shows marked vertical jointing. Few outcrops of rhyolite are seen until the top is reached. At one place on the steep climb an unusual conglomerate of rhyolite cobbles in a sparse, dark shaly matrix occurs, probably a mudflow.

Return along the Boonah-Ipswich Road or if time permits, detour west from Milbong for 2.7 km passing over at least three minor intrusions, and then travel north and northwest over Walloon Coal Measures intruded by trachyte sills and microsyenite. Continue northerly towards Peak Crossing, turning right along Faulkners Quarry Road (**Stop 8**). The fresh rock in the hilltop quarry is in large boulders. It is a coarse porphyritic teschenite, or analcime dolerite, showing spheroidal weathering. Minerals present are plagioclase, titanaugite, ilmenite and analcime. It has been isotopically dated as Late Oligocene, about 29 m.y.

From the hilltop, quarries of the Flinders Dolomite Company, in magnesian limestone (dolomite) can be seen to the east. The deposits are probably Eocene, equivalent to the limestones at Queens Park, Ipswich, and like them, are associated with basaltic flows.

Additional localities: 1. Maroon Dam, south of the Boonah - Rathdowney Road. Note the landslip on the left going down the steep hill from the main road. The first road to the left leads to a lookout and picnic area above the dam. On the opposite side of the dam, the spillway quarry shows jointed rhyolite, either in two sills, or in one which has been faulted, exposing Walloon Coal Measures (shales) in the break between the two rhyolite masses. At this point, flow banding occurs at the base of the rhyolite. A dyke fissure, resulting from the removal of the weathered dyke rock, is close to the northern end of the eastern outcrop.

2. Burnett Creek Road (east of Maroon Dam). After passing the crest of a st
hill, a cutting on the left shows forking basalt dykes, intrusive into sandsto
At the foot of the hill, gravels containing rhyolitic boulders make an alluvial
Upstream, on the eastern side of the road, a shallow quarry is in trachyte
altered dolerite or microsyenite.

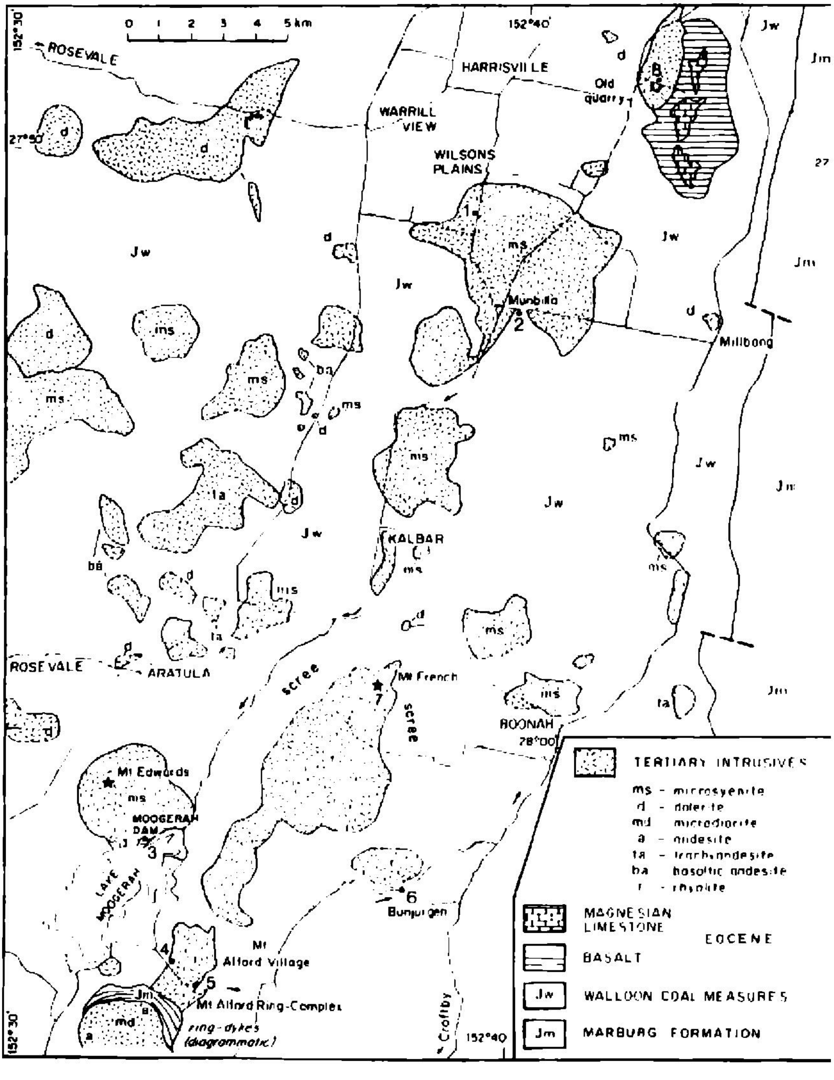


Fig. 17. Geological map of the Kalbar district.

GEOLOGY OF THE RANGES SOUTH OF BRISBANE

South of Brisbane the Beenleigh Block comprises folded Neranleigh-Fernvale beds (greywackes, slates, cherts, quartzites and basic volcanics) without Bunya Phyllite or granitic intrusions. The Block lies farther east than the D'Aguilar Block, suggesting fault movement between them, but evidence of a major fault (if any exists) may be hidden beneath the Mesozoic cover which separates the blocks to the south of Brisbane.

On the western margin of the Beenleigh Block, Mesozoic strata correlated with the Ipswich Coal Measures unconformably overlie the Neranleigh-Fernvale beds. Rhyolitic volcanics are prominent near the base of the Triassic sequence, with some basalts, as well as the usual shales and sandstones. Woogaroo, Marburg and Walloon equivalents follow to the west, gently folded into broad synclines and anticlines (Fig. 20).

Mt Warning in northern New South Wales, was the centre of a large shield volcano which was active in Oligocene-Miocene times; its lavas covered a circular area of more than 5200 km^2 and in the north the less eroded parts make the Springbrook, Lamington and Tamborine Plateaus.

The earliest basalts, however, came from centres farther west near Mt Barney and belong to the Focal Peak Shield Volcano. These, called the Albert Basalt, filled in valleys eroded in Palaeozoic and Mesozoic rocks. Rhyolites and tuffs followed, emanating from Mt Gillies and other centres in the same area. Formerly known as the Hillview Rhyolite, the formation is now called the Mt Gillies Rhyolite. In many places it is overlain by a thin but widespread layer of conglomerate and sandstone, the Chinghee Conglomerate.

The basalts which followed (Beechmont Basalt) are slightly different from the Albert Basalt and are presumed to have come from the direction of Mt Warning. Rhyolites and tuffs were then erupted from vents on the northern and southern flanks of the shield volcano; these have been named Binna Burra and Springbrook Rhyolites on the northern flanks, and Nimbin Rhyolite on the southern flanks. The Hobwee Basalt completes the volcanic sequence, which has a maximum total thickness of over 1000 m.

Most of the Mt Warning mass consists of coarse-grained igneous rocks, syenite and gabbro, but the peak is of finer-grained trachyandesite, which is presumed to have been intrusive into rocks since removed by erosion. A composite ring-dyke of trachyte, basalt, and alkali syenite forms a collar-like ridge around the main mass.

Probably influenced by the circular structure, the arms of the Tweed River have eroded a wide depression, an erosion caldera, around the central igneous complex, removing any cover of lavas from the central part of the shield volcano, and exposing the Palaeozoic and Mesozoic basement rocks in the valley floor. Cliffs showing the numerous horizontal lava flows rise sharply from the floor of the erosion caldera, forming an outer rim, on which are situated high points of the McPherson, Tweed and Nightcap Ranges. From the caldera rim, dissected plateaus parallel to the surface of the flows slope away gradually in all directions.

In the Mt Barney-Mt Ballow area, another Tertiary ring-complex is a less obvious source for lava flows. In this case, several centres of intrusion are along an east-west line. Focal Peak, presumed to be a major source for the Albert Basalt, has central volcanics (basic lavas and pyroclastics), plutonic gabbro and syenite, and a small caldera. It is surrounded by dolerite cone-sheets (which dip in towards the centre). Mt Gillies consists of rhyolitic pyroclastics and flows with numerous dykes and is the source of the rhyolite of the same name, which makes up the spectactular cliffs of Mt Lindesay. Between Mt Gillies and Focal Peak is the intrusive granophyre mass of Mt Barney. This rock shows by its texture that it crystallized beneath the surface, and age determinations suggest that it has been quickly elevated above the surface, as boulders of the rock have been found beneath the Beechmont Basalt. The granophyre boss is bounded by ring-faults. Sedimentary rocks of Carboniferous age have been dragged up around the margins of the granophyre and generally show steep dips. They are faulted against the Mesozoic sandstone, shales and conglomerates.

11. MT BARNEY

Features: Boss and dykes of Tertiary granophyre (part of ring-complex) intrusive into Carboniferous sedimentary rocks, Mesozoic sedimentary rocks intersected by a major fault.
Route: From Mt Lindesay Highway south of Palen Creek towards Barney View to Yellow Pinch.
Maps: Fig. 19, Woodenbong 1 : 50 000 map or Mt Lindesay 1 : 100 000 map.

Turn right onto the Barney View Road from the highway and follow the narrow sealed road (without taking right turn to Barney View) for 6 km and turn left at a T-junction. The gravel road goes south past a trachyte dyke forming a ridge on the right and crosses the Logan River twice before Yellow Pinch camping area.

From the south end of the camping area walk northwesterly to the river and follow it upstream to an exposure of sandstones, shales and coal lenses of the Woogaroo Subgroup. Dips become steeper adjacent to a major fault, the ring-fault which encloses a block of Carboniferous Mt Barney beds, a strip of Mesozoic rocks on the east and the mountain mass of granophyre on the west. Recent gravels occur around the next bend upstream before entering a gorge cut through a thick dyke of granophyre.

The track south from the camping area enters National Park and passes over Yellow Pinch, in dipping Woogaroo Subgroup rocks, and follows Cronans Creek. The ascent of Mt Barney is easiest up South Ridge, beginning at a track which branches off the main track just before the second major tributary creek from the northwest. The track crosses a granophyre dyke and Carboniferous rocks in which bryozoa have been found before reaching the faulted junction with the main mass of granophyre (which is strongly jointed and intruded by basalt dykes).

The granophyre occurs at a lower level at the Lower Portals on Mt Barney Creek (no access for vehicles at the time of writing). It is possible to reach the

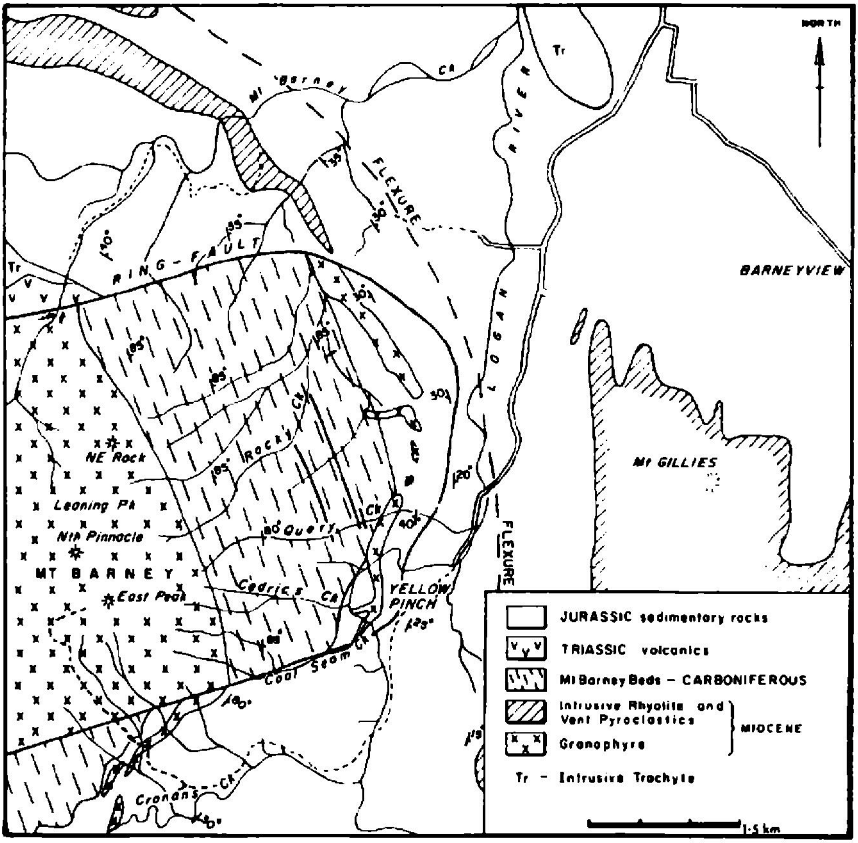


Fig. 19. Geological map of the Mt Barney area.

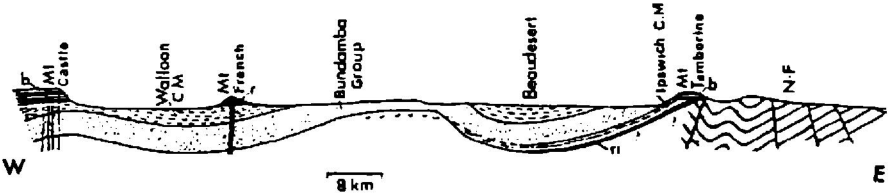


Fig. 20. Geological section from the Main Range near Mt Castle (west) to Southport (east), vertical scale exaggerated. N-F: Neranleigh-Fernvale beds; ri: Chillingham volcanics; v: andesite to basaltic volcanics, unknown age; b: Tertiary basalts; r: Tertiary rhyolite. Folding in N-F diagrammatic.

Upper Portals, also in granophyre, by road from Maroon (10 km) thence by a rough four-wheel drive track for 9 km, passing over sandstone (to Grace's Hut) and intrusive trachyte.

12. MT TAMBORINE, CANUNGRA

Features: Tertiary basalt, Mesozoic sedimentary and volcanic rocks, Neranleigh-Fernvale beds.
Route: Outwards via Beenleigh, return via Mt Lindesay Highway (about 170 km).
Maps: Fig. 21, Beenleigh and Murwillumbah 1 : 100 000 geological maps.

Tamborine Plateau is capped by almost horizontal flows of Early Miocene basalt (Beechmont Basalt) from the Mt Warning centre, overlying Albert Basalt of the Focal Peak Shield Volcano. The plateau has been isolated by erosion, as Canungra Creek has cut down below the Tertiary basalts into Mesozoic sandstones (Woogaroo Subgroup), Ipswich Coal Measures and Chillingham Volcanics.

Stop 1. Near Wolffdene, 7.5 km past Beenleigh on the Tamborine Road, before rest area. An old road cutting to the left of the present road, closer to the river, shows folded cherts of the Neranleigh-Fernvale beds. The chert beds are of almost uniform thickness and are separated by thin shale layers.

The road passes over thin layers of Triassic volcanics and Ipswich Coal Measures after Cedar Creek, then onto Woogaroo Subgroup sandstones which are best seen (**Stop 2**) 2.5 km after leaving Tamborine Village on the approach to Tamborine Mountain. Horizontal layers of basalt can be distinguished by cliffs on the escarpment.

Stop 3. A short distance beyond a sharp left-hand curve at the foot of the hill 4.6 km from Tamborine Village, a basaltic dyke has intruded the sandstones. It shows slight marginal chilling, but no contact metamorphism.

As the road rises, successively lower strata appear since the dip (westerly) is steeper than the slope of the road. A good section through the Ipswich Coal Measures is exposed.

Stop 4. About 1.8 km past **Stop 2**, a road to the left leads to Cedar Creek Falls (a National Park). The falls are in massive greywacke of the Neranleigh-Fernvale beds; the overlying basal conglomerate may be seen in a gully to the southeast.

'Thunder eggs' (nodules filled or partly filled with agate, chalcedony or quartz) are obtained from the Triassic rhyolitic volcanics. Specimens may be bought and prospected for at 'Thunderbird Park' nearby.

Stop 5. At an S-bend 1.6 km up the main road from the Cedar Creek Falls turn-off, Triassic tuff and rhyolites (including spherulitic types) are found along a rough track to the left (from the first sharp right curve). The lowermost Tertiary basalts can be seen after the S-bend.

Stop 6. Turnoff (left) to Eagle Heights. On porphyritic basalt, with large plagioclase phenocrysts. At Curtis Falls (in Joalah National Park, walking track entrance north of the road junction), the basalt shows vertical columns and rests on carbonaceous clays.

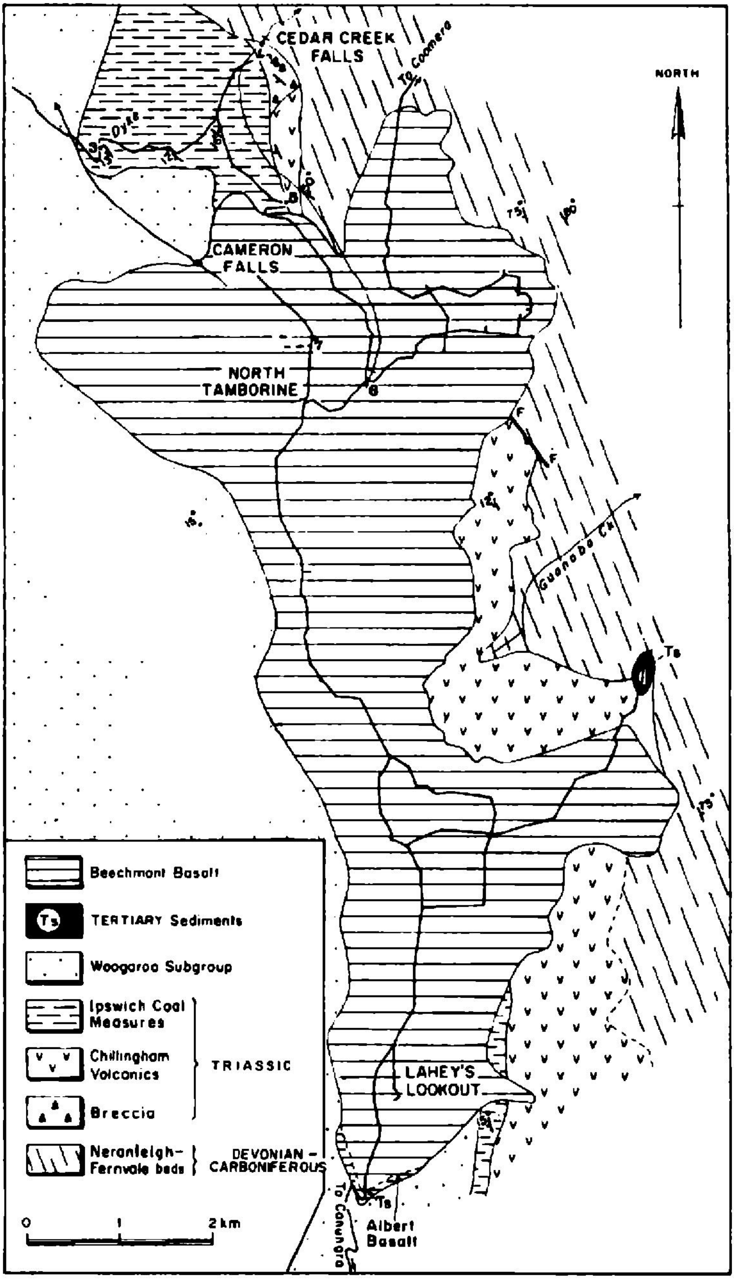


Fig. 21. Geological map of the Mt Tamborine Plateau.

Stop 7. North Tamborine Post Office. Bauxite was once quarried 250 m to the west, but little now remains to be seen.

The road south along the western margin of the plateau gives good views to the west and southwest. The double-tiered Mt Lindesay to the southwest is a lava residual and most of the other conspicuous peaks are Tertiary intrusive rocks e.g. Mt Barney and Mt Ballow to the southwest, and Flinders Peak to the west.

If time permits the descent from the plateau may be made at the southern end by a steep, narrow (one lane sections) and partly gravel road to join the Beechmont-Canungra Road. Cliffs near the start of the descent are of porphyritic basalt; about halfway down the hill at a sharp bend, the Beechmont Basalt is underlain by Tertiary clays and sandstones or tuffs with plant remains, and below these is the alkaline Albert Basalt.

Alternatively, the descent may be made from the northeast end of the plateau to Upper Coomera, passing over Neranleigh-Fernvale beds including greenish basaltic rocks with pillow structure on the last curve before Howard Creek. Jaspers in the Neranleigh-Fernvale beds are commercially exploited at 'Jasper Farm'.

Additional locality: Coomera Gorge Road (Canungra-Oxenford), beginning about 2 km from the junction with the Beechmont-Canungra Road a section through the Chillingham Volcanics shows (1) white rhyolite in a quarry on the left; (2) a thinly-banded rhyolite, sub-horizontal, with spherulites to 3 cm and lenses of green clay; (3) a recumbent fold in rhyolite flow layers against shale; (4) rhyolite tuff and tuff-breccia unconformably overlying breccia, sandstone, shale and conglomerate, faulted against steeply dipping dark shale, brecciated rhyolite and tuffaceous sandstone (Fig. 22).

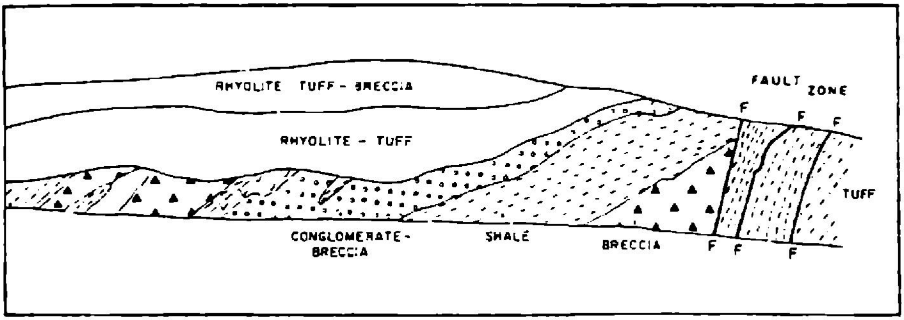


Fig. 22. Geological sketch section, Coomera Gorge Road near Canungra (modified from a sketch by D.C. Green).

13. BINNA BURRA (LAMINGTON NATIONAL PARK)

Features: Tertiary basalts, rhyolite lavas and tuffs, intrusive rhyolite, Mesozoic sedimentary and volcanic rocks.
Route: Via Pacific Highway, Nerang, Beechmont, returning via Canungra (about 240 km).
Maps: Figs 23, 25; Murwillumbah 1 : 100 000 geological map, Canungra 1 : 50 000 maps.

For details of geology between Brisbane and Nerang, see Highway Geology. At Nerang take the road to Beechmont. The road rises through hilly, forested country composed of Neranleigh-Fernvale greywackes. The first area of Tertiary basalt (open, pastoral country of Lower Beechmont) is entered about 6 km past the turnoff to Numinbah Valley. The road continues through basalt country for about 3 km, and though gradually rising, passes onto Neranleigh-Fernvale rocks again (including basic volcanics with poor outcrops) and overlying Triassic volcanics, exposed in an old quarry on the right-hand side of the road. Tertiary basalt is seen again, overlying Triassic tuff, on the last steep hill before the Beechmont Plateau is reached.

Stop 1. Rosins Lookout, an environmental park 6.4 km from the beginning of the higher Tertiary basalt. On a clear day, Mt Warning may be seen through the gap at the head of Numinbah Valley. The light-coloured cliffs are the rhyolites and tuffs of Binna Burra and Springbrook, which are interlayered with basalt flows: Beechmont Basalt beneath, Hobwee Basalt above.

At Beechmont School, turn left towards Binna Burra. Some exposures of the Beechmont Basalt are seen 5 km past the turnoff.

Stop 2. Both vesicular and porphyritic types are present; red horizons indicate tops of flows.

Stop 3. National Park sign and walking track entrances at the base of the hill below Binna Burra. Cuttings on the east side of the road 100 m back from the stopping place show exposures of basalt and bedded rhyolite tuff. The latter cuts out to the north against basalt which may be locally intrusive, and is overlain by basaltic agglomerate.

The walking track to the swimming hole on the Coomera River descends through bedded rhyolitic tuffs of the Binna Burra Rhyolite, which become less distinctly bedded farther down the track and pass into an ash-flow tuff. At the base of a cliff exposure carbonized tree trunks are included in the tuff.

The walking track to White (or Talangai) Caves leaves the road just above the track to the swimming hole. The caves (Fig. 24A) are in bedded tuff (graded in places) and are caused by the combined effects of wind erosion and softening of the tuff by groundwater. Around the corner from the caves, tuff lies against a sloping surface of the underlying glassy lava. After returning to the main track, continue along it for about 400 m to a short tunnel in brecciated glassy lava linking Kweebani Cave with the Aboriginal Cooking Cave. This rock was originally an obsidian (a black, glassy form of rhyolite), but has been altered by taking up water resulting in a pale grey perlite. The flow has been broken up during movement into angular fragments of various sizes and shapes, and may be the

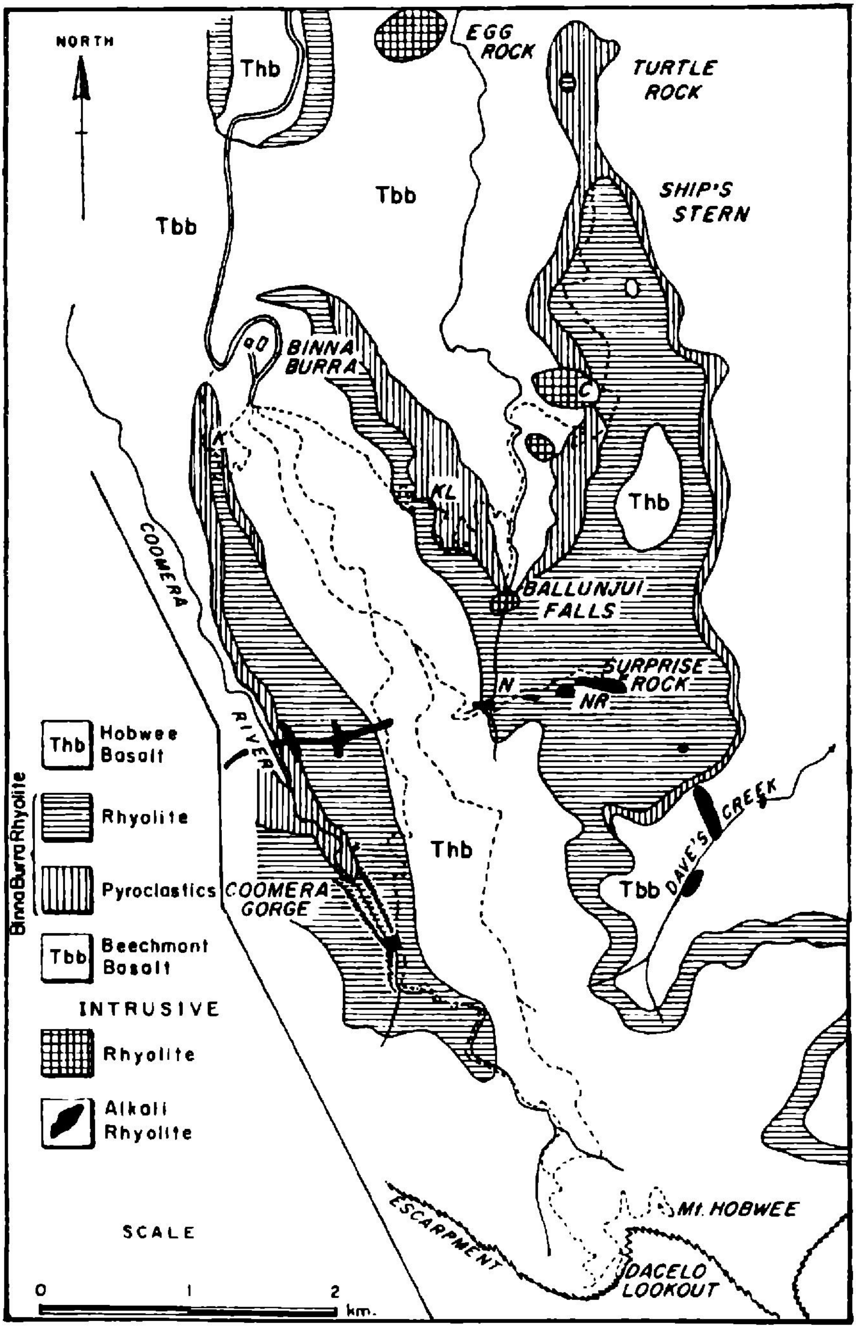


Fig. 23. Geological map of the Binna Burra area.

filling of a volcanic pipe (note the cliff section seen to the south from the steps of the Cooking Cave).

The track continues down to the base of the perlite breccia, and on for several km climbing up through rain forest with few outcrops of the overlying basalt to a point on the road between Binna Burra Lodge and the parking area. Alternatively, return to the road, and proceed up the hill, passing two horizons of glassy rhyolitic rocks interlayered with basalts. The road is narrow and dangerous (single lane in places), so it is better to drive to the top (**Stop 4**, parking area, Windy Corner) and walk 50 m or so down the road, where an oxidized red top to a basalt flow of the Hobwee Basalt is covered by a later flow. Both flows have plagioclase phenocrysts.

Stop 5. Parking and picnic area, end of the road, Binna Burra.

Most of the walks to geological localities from this point require at least several hours, those to Ships Stern (19 km) and the border lookouts (18 km) require a full day.

An interesting short walk is to Koolanbilba Lookout and Cave (about 6 km) on the track to Ballanjui Falls and Ships Stern. It starts at the base of a steep, grassy slope north of the parking area, and for the first 2 km is on Hobwee Basalt, without conspicuous outcrops. Koolanbilba Lookout is on Binna Burra Rhyolite; across the valley to the north and east, the upper cliffs are of rhyolite and the lower ones are of the underlying tuff. Turtle Rock, north of Ships Stern is composed of this tuff; Egg Rock which stands apart from the main cliffs, is probably a vent.

Koolanbilba Cave, on the main track, below the Lookout, is at the base of cliffs of nearly horizontal flow-banded rhyolite; in the cave, hemispherical 'spheruloids' several cm in diameter are seen on the roof of the cave, and in cavities which parallel some vertical, folded flow layers. The spheruloids are primary structures, formed during solidification of the rhyolite lava. Farther down the track, a brecciated glassy rhyolite with dark, obsidian-like fragments in a more weathered, grey matrix, is exposed about 70 paces past the turnoff to Yangahlah (Picnic) Rock.

If time is available the track may be followed past Kong Gong Rock (large rhyolite boulder), turning left at marker post AA96 (about 5 km from Binna Burra) to a cliff of tuff containing boulders and smaller rounded fragments of basalt as well as rhyolite. Farther on, Ballanjui Falls are in intrusive rhyolite, which shows dipping flow layers at a angle to those of the main rhyolite flows. Clearer evidence of discordant structures (a steep dip of columns on the eastern edge) is seen in the intrusive rhyolite of Charraboomba Rock.

Surprise Rock (13 km return walk) is a dyke of alkali rhyolite showing well-developed horizontal columnar jointing at the east end. Grooves formed by solution and spherulites stretched by movement of viscous magma against the wall of the dyke are seen on the south side. The surrounding swampy country is on the surface of the Binna Burra Rhyolite, into which the dyke is intrusive. Nagarigoon Falls and Neubani Rocks are in the same, or similar offset dykes.

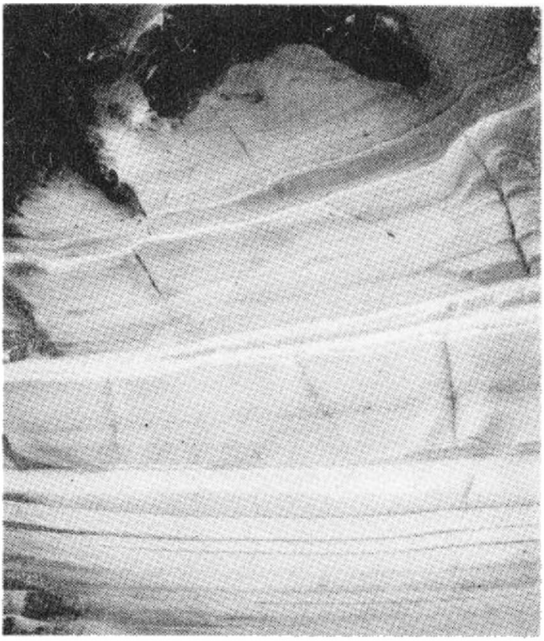
Coomera Gorge and border lookout walks. The track is over Hobwee Basalt for most of the way to the border lookouts, except at the head of the Coomera

Gorge (in Binna Burra Rhyolite) and 0.8 km past the turnoff to Tullawallal Lookout, on the Coomera River track, where a dyke of alkali rhyolite (soft, greenish-coloured) is exposed. Excellent views of Mt Warning and its erosion caldera are seen from the border lookouts.
Stop 6. 1.7 km past **Stop 3** (National Park boundary) road cuttings show a variety of volcanic and pyroclastic rocks (from south to north: a rhyolite tuff with basalt boulders, an agglomerate bed of basalt boulders dipping at a low angle, rhyolite tuffs, rhyolites and breccias with some vertical beds). The different attitudes of beds and the presence of coarse pyroclastics suggest a centre of eruption.

At Beechmont School, turn left towards Canungra. On the Beechmont-Canungra Road, about 1.3 km after the start of the descent from the plateau ('steep hill' warning sign), sandstone, clay and diatomite are interbedded with the Beechmont Basalt.
Stop 7. 0.8 km farther on, just past a sharp turn left on a steep downhill slope. Road cutting (Fig. 24B) in friable sandy sediment with boulders and pebbles of rhyolite, pitchstone and basalt, interpreted as a lahar (volcanic mudflow). It is at the base of the Beechmont Basalt, at an horizon equivalent to that of the Chinghee Conglomerate, and may have come from the direction of Mt Barney to the southwest (fossil twigs in the deposit are oriented in this direction).
Additional localities: Springbrook Plateau, access from Numinbah Valley Road, or from Pacific Highway. On the western slope of Springbrook Plateau, basalt occurs between two rhyolite flows each about 100 m thick; the upper rhyolite is stratigraphically higher than the top of the Binna Burra Rhyolite and may be younger. The Albert Basalt has thinned out in this area and the lowest basalt (of the Beechmont Basalt) rests unconformably on Palaeozoic Neranleigh-Fernvale beds. 1. The Glass Cutting, just past the intersection of roads from Nerang and Mudgeeraba and before the road divides into one-way traffic lanes to climb up the bluff of Springbrook Rhyolite. The base of the flow is pale grey to dark perlite, in places almost obsidian.
2. Purlingbrook Falls (take a short branch road to the left). The cliffs are formed from a rhyolite flow. Perlite occurs at the base, and beneath it several flows of basalt outcrop, each with a vesicular top. The measured basalt flows average 7 m thickness.

14. NUMINBAH VALLEY, MT WARNING

Features: Oligocene-Miocene Tweed Shield Volcano with central mass of intrusive gabbro, syenite, trachyandesite and ring dykes; basalt-rhyolite lava succession resting on Palaeozoic and Mesozoic sedimentary and volcanic rocks.
Route: Outwards via Pacific Highway, Nerang, Numinbah Valley, return via Murwillumbah and Gold Coast (about 330 km, 1-2 days).
Maps: Fig. 25, Burleigh and Murwillumbah 1 : 100 000 geological maps, Canungra, Tyalgum and Murwillumbah 1 : 50 000 maps.



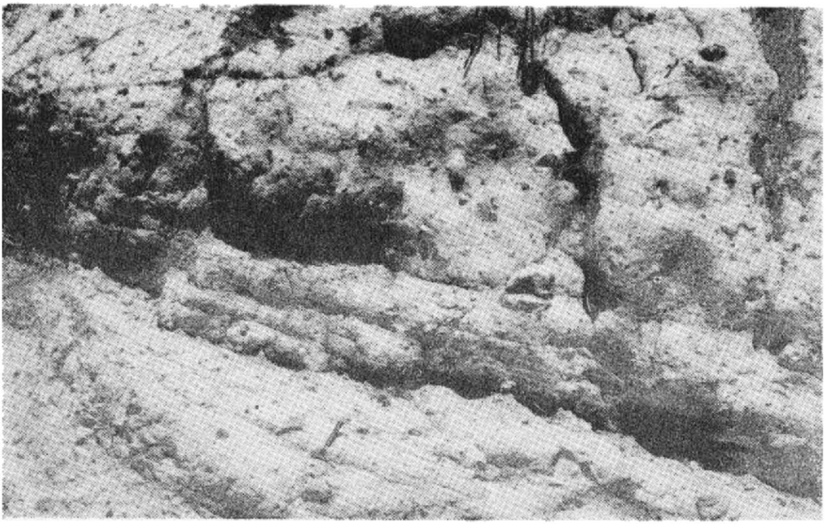


Fig. 24. A: White Cave, Binna Burra. B: Road cutting, Beechmont-Canungra Road, showing lahar deposit.

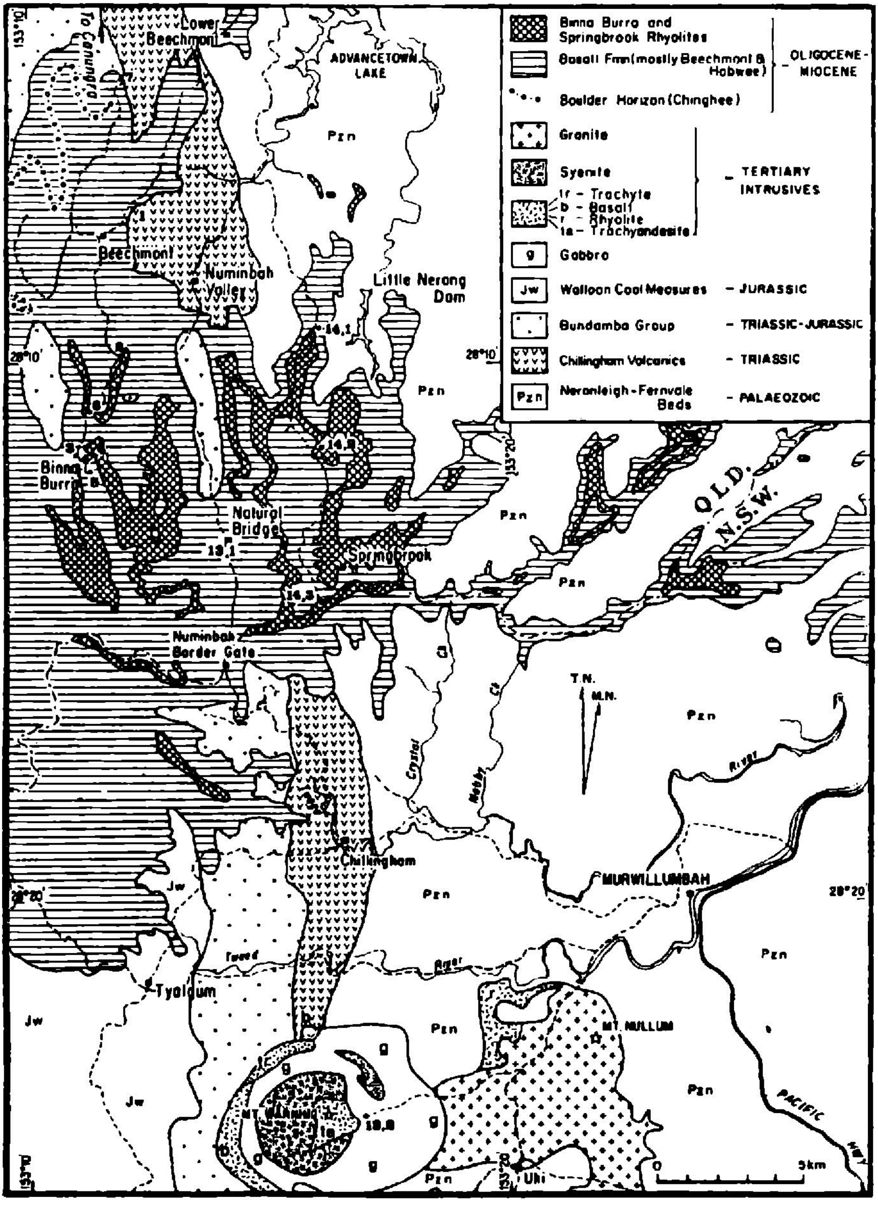


Fig. 25. Geological map, Numinbah-Mt Warning.

The route to Nerang and Numinbah Valley passes mainly over Neranleigh-Fernvale beds, well exposed in numerous cuttings in hilly country south of the Beechmont Road junction. Past the Nerang River crossing and before Numinbah Valley township, Triassic rhyolites with flow layering unconformably overlie the Neranleigh-Fernvale beds, and are exposed in an old quarry (221876 Canungra). This is part of the same belt of volcanics (Chillingham Volcanics) that passes under the Tertiary capping of Mt Tamborine.

Farther south the road follows the valley of Nerang River with the Binna Burra Rhyolite (rhyolite of Ship Stern overlying tuff) to the west (Fig. 26) and the Springbrook Rhyolite to the east. The route is over Mesozoic sandstones, then the overlying Tertiary basalts.

Stop 1. Natural Bridge National Park. Side road to the east, follow signs to walking circuit. The feature has been formed by partial collapse of the roof of a cave, scoured out beneath a waterfall. The creek now enters the cave through the hole in the roof and flows beneath the arch. The roof of the cave is basaltic lava, and this rests on a more easily weathered brecciated lava.

South of Natural Bridge, the valley narrows and the divide is crossed at the border gate, a low gap in the erosion caldera rim caused by the capture of the headwaters of the Nerang River by the more vigorously eroding tributary of the Tweed River. The horn-like peak of Mt Warning, surrounded by a circular ridge representing the main ring-dyke, can be viewed from this point.

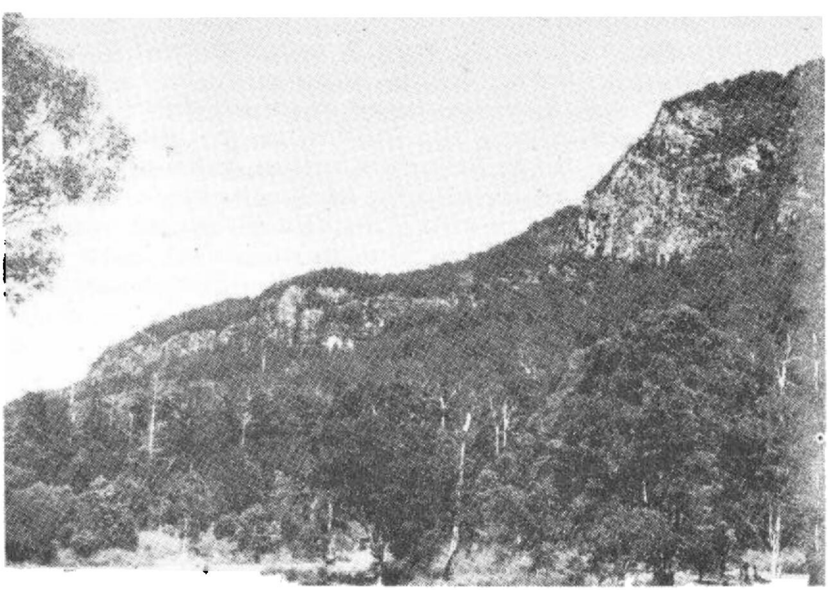


Fig. 26. Rhyolite cliffs, Numinbah Valley.

On the descent to Chillingham the road passes from Tertiary basalts of the shield volcano to the underlying Mesozoic sandstones which form the floor of the western part of the erosion caldera. Rhyolites of the Chillingham Volcanics are next seen in cuttings past Settlement Road. The dip of the Mesozoic rocks is to the west, off folded Neranleigh-Fernvale beds (slates) which occur to the east of Chillingham.

The direct route to Mt Warning is east towards Murwillumbah, then south-west, but if time is available the road through Tyalgum may be taken, passing over Mesozoic sandstones and shales with several minor intrusions (e.g. grey porphyritic andesite about 4.3 km after Chillingham and a rhyolite sill 4 km east of Tyalgum).

About 7 km past Tyalgum the Mesozoic sandstones give place to the underlying Chillingham Volcanics, which are intersected by basaltic dykes. The western outcrops of the volcanics are tuffs and breccias, underlain by ignimbrite and flow-banded rhyolites. A porphyritic dolerite with large plagioclase phenocrysts has intruded the ignimbrite.

The Uki Road is then followed along the South Arm of the Tweed River; outcrops seen are fine-grained granite extending down from Mt Nullum (east) and intrusive rhyolite forming cliffs to the west. About 6 km along the Uki Road, a sealed road to the right is taken, crossing the river and climbing up to the eastern base of Mt Warning.

Stop 2. Road end, Mt Warning National Park, about 400 m above sea level. The foot track, which rises 760 m to the summit in 4.3 km, passes from gabbro onto syenite after about 1.6 km and then onto trachyandesite, in jointed outcrops on the final steep climb to the summit. From the summit an unrestricted view of the erosion caldera is obtained, with the caldera walls, mostly basalt, in the middle distance. The ring-dyke around the northern and western sides of the mountain is also visible. Allow at least four hours for the climb up and back.

On the return trip from the parking area, gabbros, with some fallen blocks of syenite are along the roadside in the first few hundred metres. Monzonite is found about 2-2.5 km from the parking area; farther down, the road crosses hornfels derived from Palaeozoic rocks, with well-developed quartz veining.

The return trip to Brisbane may be made via Murwillumbah and the Gold Coast.

GEOLOGY OF THE RANGES AND COASTAL PLAIN BRISBANE-MARYBOROUGH

The predominantly metamorphic rocks of the ranges NNW. of Brisbane constitute the D'Aguilar Block, which is divided into a northern and southern section by a major fault, the North Pine Fault. The South D'Aguilar Block is made up of the Bunya Phyllite and the Neranleigh-Fernvale beds, but these are not recognizable in the North D'Aguilar Block, where the metamorphics are thought to be somewhat younger, of Carboniferous-Permian age.

The North Pine Fault cuts acutely across the regional trend of the Bunya Phyllite, bringing it in contact with an extensive belt of metamorphosed basic volcanic rocks, the Rocksberg Greenstone, which forms hilly country between Petrie and Woodford. On the eastern side of the Rocksberg Greenstone, a belt of phyllites with lenses of basic metavolcanics is known as the Kurwongbah beds. These are faulted against Triassic-Jurassic sandstones and shales to the east.

At Dayboro and around Woodford and Conondale, granitic rocks have intruded the metamorphics. Farther to the northwest, low-grade metamorphics, mainly slate and phyllite with greenstones, small lenses of jasper and chert, and some thin beds of sandstone and siltstone, have been named the Booloumba beds. They appear to underlie conformably the Amamoor beds, which contain Early Permian fossils (SSW. of Kenilworth). These beds comprise pebbly mudstone, feldspathic sandstone, siltstone, slate, jasper, conglomerate and basaltic volcanics. Other formations of approximately the same age are the Cedarton Volcanics and Bellthorpe Andesite.

Northeast from Kenilworth, the Amamoor beds give place to the Permian Gympie Group, which is less metamorphosed and contains, besides sandstone, shale, siltstone and basic volcanics, thick beds of limestone with marine fossils, including brachiopods, molluscs, corals, gastropods and bryozoa. This belt continues north-northwest to Biggenden. Early Triassic rocks (Keefton Formation and Kin Kin beds) are also marine in this area and, like the Permian Gympie Group, are strongly folded.

Deformation and metamorphism in the North D'Aguilar Block is thought to have taken place during latest Carboniferous to earliest Permian times. Some of the granites in the north were intruded about this time, others in the south were much later, in the Triassic. Serpentinite, which makes up large areas NW. of Kenilworth and extending through to Kilkivan, was probably emplaced along thrust faults in the Early Permian.

Middle to Late Triassic and Jurassic strata are freshwater deposits, formed in lakes like those near Brisbane and Ipswich and to the south. Subdivision and formation names vary according to the basins in which they occur. Two Mesozoic basins are recognized in the coastal region: the Nambour Basin and the Maryborough Basin; the latter persisted into the Cretaceous and includes marine strata.

The lower formation in the Nambour Basin is the North Arm Volcanics, composed of rhyolite, ignimbrite, tuffs and some andesitic volcanics. It is over-

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The lower formation in the Nambour Basin is the North Arm Volcanics, composed of rhyolite, ignimbrite, tuffs and some andesitic volcanics. It is over-

lain by the Landsborough Sandstone, which is largely Jurassic.

In the Maryborough Basin the Triassic and Jurassic formations are mostly sedimentary (Brooweena Formation, Myrtle Creek Sandstone, Tiaro Coal Measures). Earth movements in the Late Jurassic were accompanied by intrusion of quartz diorite at Noosa and finer-grained andesitic intrusives at many places in the Maryborough Basin and as far south as Maroochydore. Magma reached the surface in the Maryborough Basin producing andesites, trachytes and rhyolites of the Grahams Creek Volcanics. Marine conditions followed, with the deposition of shales and sandstones (Maryborough Formation) in the Cretaceous Period. The sea then withdrew leaving freshwater swamps in which the Burrum Coal Measures were formed. In the Late Cretaceous these strata were gently folded and faulted.

In the Tertiary Period, thin formations of freshwater sediments were deposited over parts of the Maryborough Basin and near Pomona on the southern margin. The principal igneous events were the outpouring of basalts in the Maleny-Mapleton district, Wolvi Range and near Childers, and the formation of the volcanoes of the Glass Houses and the Coolum-Cooran district. Most of this activity took place in the Late Oligocene. Subsequently, the area remained relatively stable, and deep weathering and laterite soils developed. In at least two places, abrupt changes of level or escarpments formed because of erosion by coastal streams: one of these is in the Glass Houses area, the other, near Tewantin, is called the Como Scarp.

In the Bundaberg district and in the valleys of the Burnett River and Barambah Creek, basalt flows in the Pleistocene modified the existing surface. The vents for the Barambah Basalt are seen at Coalstoun Lakes as two craters and nearby dome-shaped hills.

Along the coast, erosion by the sea of the high sand dunes has exposed some spectacular sections at Cooloolah between Noosa and Double Island Point. The dunes are mostly blow-out dunes, narrow U-shaped or V-shaped when seen from above, caused by strong southeasterly winds. They occur in overlapping dune systems, the oldest (which are farthest away from the coast) extending at least back to the last interglacial period, more than 140 000 years ago. Sections at the coast may show more than one dune system, with irregular junctions between them, due to erosion prior to the deposition of the later sands. Dark layers beneath white sands have been produced by downward movement of organic material through the sand by the agency of percolating water. Iron compounds are similarly transported making the sand a bright yellowish brown; they are also responsible for the varied colours of the 'coloured sands' of Teewah. The sands thus show 'horizons' (A_1, dark at the top; A_2 bleached, under A_1; B, zone of accumulation, beneath A_2) such as are found in soils. The older the sand, the deeper it is to the organic/iron oxide horizon (more than 20 m beneath the oldest dunes).

Similar features are found on Fraser Island, which consists mainly of Quaternary sands with some volcanic rock outcrops (trachyte) at Indian Head and Waddy Point.

15. MT MEE

Features: Palaeozoic Rocksberg Greenstone, phyllites, Palaeozoic granite, granophyre, Tertiary basalt, faulted contact with Mesozoic rocks.
Route: Petrie, Dayboro, Mt Mee, returning via Woodford and Caboolture (about 200 km).
Maps: Fig. 27, Caboolture 1 : 100 000 geological map.

The greenstones have been formed by low-grade regional metamorphism (greenschist facies - typical minerals actinolite, epidote, albite, chlorite) of a thick layer of basic tuffs and lavas, probably deposited under submarine conditions, and including some basic intrusions. They have a faulted contact with the Bunya Phyllite to the west, and the eastern side of the greenstone belt appears to be conformable with phyllites of the overlying Kurwongbah beds, which, with the greenstones, have been subjected to three deformations. The first produced a major antiform with Rocksberg Greenstone in the core, whereas the second caused smaller-scale folding with low-dipping, northerly-plunging axes. The third deformation was weak and affected only the phyllites. Structures resembling bedding, more obvious in the phyllites than the greenstone, are lenticular, and are explained by separation and transportation of the limbs of isoclinal folds parallel to the axial plane i.e. they have a tectonic rather than a sedimentary origin.

The age of these formations is thought to be Carboniferous; they pre-date the fold movements and metamorphism, assumed to be Late Carboniferous.

The older rocks have been intruded by the Dayboro and Neurum Tonalites of Early and Middle Triassic age respectively.

Stop 1. Petrie-Dayboro Road. 0.6 km past Sideling Creek (view of Lake Kurwongbah on the right). An exposure of phyllites of the Kurwongbah beds is on the left of the road. At the northeastern end of the Lake Kurwongbah dam wall, highly folded phyllites and metamorphosed basaltic volcanics are exposed in the spillway. The most prominent folds are associated with the second phase of deformation. Fault zones associated with quartz veins occur in parts of the outcrop.

Between Stop 1 and Dayboro the newer section of the road (3-11.5 km past Stop 1) shows numerous cuttings through the greenstones.

Stop 2. Rush Creek, at junction with a minor road (to left), a prominent lineated surface of greenstone is seen after crossing the bridge. Opposite it, on the east side of the minor road, pods of quartz occur.

The main road passes over weathered granitic rock within 1.5 km of Dayboro. At Dayboro turn right towards Mt Mee after Terrors Creek. Between 4 and 5 km from this corner porphyritic greenstone with large, well-formed relict pyroxene crystals has been collected, but the road is narrow with few stopping places. Similar rocks occur just before Terrors Creek bridge 5.8 km from Dayboro. Agglomerates containing metabasalt fragments (10-30 cm) and more deformed ellipsoidal masses occur in Terrors Creek.

Stop 3. 14.2 km from Dayboro. Banded lustrous schists, a phase of the Rocksberg Greenstone. About 1 km past this point, the greenstones have been intrud-

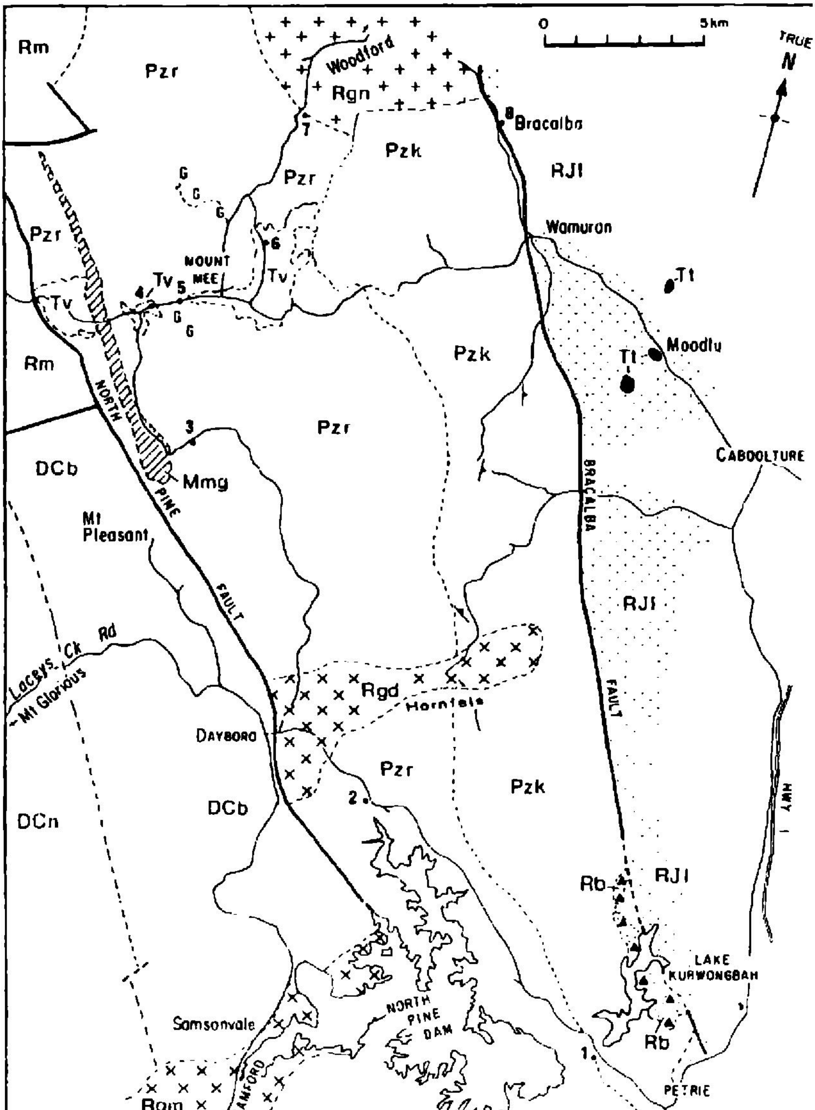

Fig. 27. Geological map, Dayboro-Mt Mee: DCn: Neranleigh-Fernvale beds; DCb: Bunya Phyllite; Pzr: Rocksberg Greenstone; Pzk: Kurwongbah beds; Rm: Mt Byron beds; Rb: Brisbane Tuff; RJl: Landsborough Sandstone; Rgd, Rgm, Rgn: granitic-dioritic rocks; Mmg; granophyre; Tv: Tertiary basalt; Tt: trachyte.

ed by granophyre (contact not visible), a pale pink or cream rock with bluish spots (chlorite). The road follows this wide dyke for more than 2 km then passes over schists and greenstones with a thin capping of Tertiary basalt to Mt Mee.
Stop 4. The fresh basalt is exposed in a cutting 0.5 km past the Mt Mee Forestry Road.
Stop 5. 0.75 km from **Stop 4**. A low, weathered road cutting (left side) in which the schistose rocks have a bluish colour because of the presence of the amphibole glaucophane, formed as a result of high ferric iron content in the original basic volcanics. An alternative site is on a NE.-flowing tributary of Culvert Creek (0.8 km after right turn on secondary road to the left, 2.7 km north of Mt Mee).
Stop 6. Small quarry, east side of the more easterly of the two roads to the north of Mt Mee and 3 km from Mt Mee School. The zeolites chabazite and natrolite occur in amygdules in weathered Tertiary basalt.

The road descends to Delaneys Creek past many greenstone cuttings; 1 km after crossing the creek the contact with a tongue of granitic rocks is exposed on the right (**Stop 7**).
Stop 8. 5.7 km from D'Aguilar on the road to Caboolture, the faulted junction (Bracalba Fault) between phyllites of the Kurwongbah beds and the Landsborough Sandstone is exposed on a right-hand (west) side cutting (park near J. Lindsays Road and walk back). At first sight it appears to be a reverse fault dipping southeasterly at a low angle, but the fault is dipping steeply and the road is almost parallel to the strike of the fault, so this is only an apparent dip.

Continuing towards Caboolture, phyllites are in cuttings to the west of the fault. At 6 km from Wamuran the Mudlu quarry in dark aegirine trachyte, probably related to the Glass Houses, is passed on the right.

16. THE GLASS HOUSES

Features: Miocene volcanic plugs of alkali rhyolite and trachyte, trachyrhyolite, Landsborough Sandstone, Triassic dacitic volcanics.
Route: Beerwah, Mt Ngun Ngun, Mt Beerwah, Scenic Lookout, Beerwah (about 175 km).
Maps: Fig. 28. Caboolture 1 : 100 000 geological map (southern Glass Houses), Nambour 1 : 100 000 map.

The Glass Houses (cover photo) are a spectacular group of dome-shaped hills and conical peaks, up to 400 m above the surrounding country. They represent the eroded remnants of former volcanoes, each a separate centre of eruption. The arrangement of the igneous masses along east-west and north-south directions suggests a control by intersecting joint sets. The surrounding rocks, through which the igneous rocks were intruded, belong to the Landsborough Sandstone, with a small inlier of North Arm Volcanics.

The igneous rocks of the Glass Houses have been isotopically dated as Late Oligocene, and are the same age as the basalts to the north in the Maleny-Mapleton district.

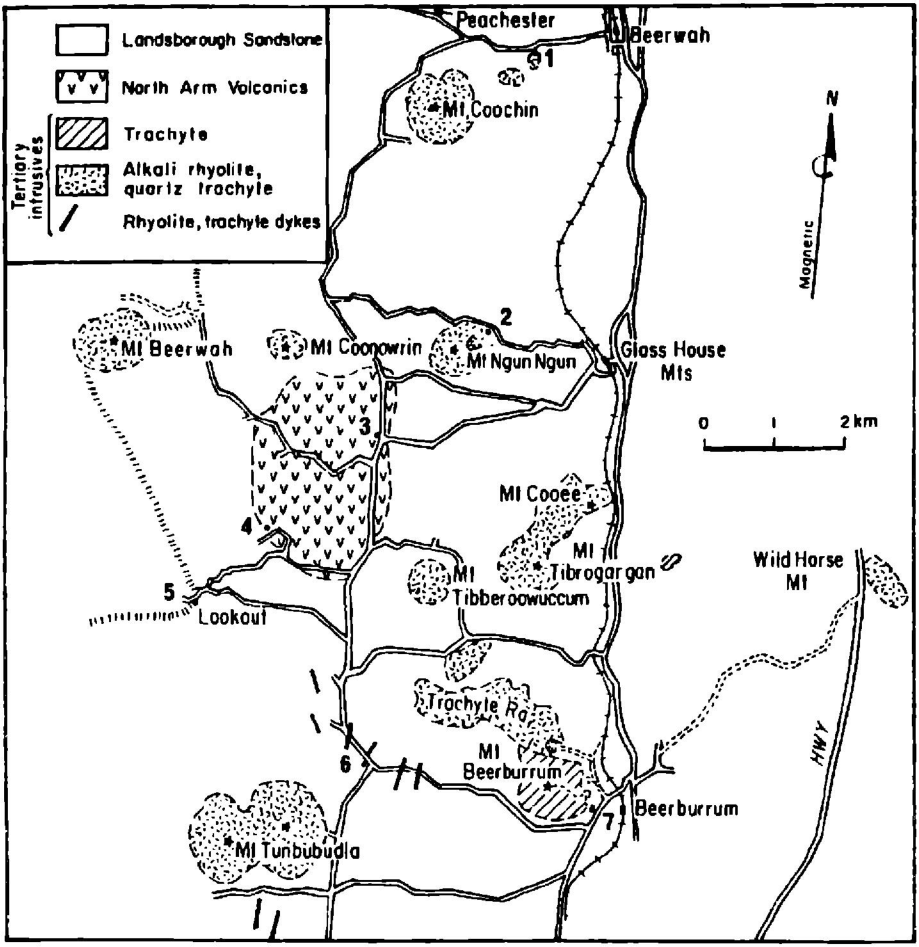

Fig. 28. Geological map of the Glass Houses.

The Late Oligocene surface, on which the basalts poured out, is now between 240 and 180 m above sea level and slopes gently easterly. The land surface at the time of eruption of the Glass Houses must have been of comparable height, so the magma of most of these eruption centres reached the surface, and probably built up steep-sided cones well above it. Any lava flows (other than those immediately above the conduits or vents) must have been eroded away in the 25 m.y. since their formation. Also, any low-level horizontal masses (such as the Trachyte Range and Mt Cooee) should be intrusions rather than flows.

Rocks from the majority of the Glass Houses are pale bluish-grey alkali rhyolites (comendites). Some rocks are entirely fine-grained but generally one or more of the constituent minerals (sanidine feldspar, alkali mafic (dark) minerals, quartz) may be large enough to be recognized in hand specimens. The most common alkali mafic mineral is riebeckite, imparting a bluish colour to the rocks. The Mt Beerwah rock is a trachyte, containing a little quartz, and the rocks from Mounts Beerburrum and Miketeebumulgrai are also trachytes, but are much darker and more obviously porphyritic than the rocks of the other Glass Houses.

Columnar jointing is a feature of most of the alkali rhyolite masses. Vertical columns are well displayed in Mounts Coonowrin (Crookneck) and Ngun Ngun; these are explained as the central cores or plugs of the volcanoes, from which the columns curve outwards to lie closer to horizontal at near-vertical contacts on the margin (now largely removed by erosion).

Stop 1. Beerwah-Peachester Road, 1.3 km west of Beerwah. A small quarry in columnar alkali rhyolite, a rock related to those of the Glass Houses. The vertical columns suggest that the intrusion is a sill or that the top of a laccolith is being exposed.

Stop 2. Ngun Ngun quarry. Several varieties of alkali rhyolite occur in this quarry, some with pronounced flow structures. Most of the quarry is in grey alkali rhyolite, but lighter-coloured 'spotted' types occur along the eastern margins of the workings, where they are associated with types showing steeply dipping flow structures. Near-vertical columnar jointing is exposed on the far wall of the quarry.

Proceed west, then south, passing the east face of Mt Coonowrin with its vertical columns.

Stop 3. At the junction with the sealed road from Glass House Mountains station. Outcrops of dacitic pyroclastics are seen on the side of the road; a Middle Triassic date has been obtained from better outcrops of dacite lava on the hill to the west, indicating correlation with the North Arm Volcanics. From **Stop 3**, the road to the south is taken for a short distance, then turn right (west) towards Mt Beerwah. 0.7 km from the turnoff a long, low cutting exposes dacitic volcanics including a stratified boulder bed about 150 m from the foot of the hill; North Arm Volcanics are exposed here because of the presence of a high area in the basement.

The road leads to a picnic area at the base of Mt Beerwah, and provides good views of Mt Beerwah and Mt Coonowrin, but is not suitable for buses. Re-

turn to the turnoff, and continue south. The next road to the right (west) is taken towards a scenic lookout.
Stop 4. On a track turning off the Scenic Lookout Road just before a house on the right. An outcrop of fine-grained basalt occurs on the track with ignimbritic rocks, probably equivalent to the North Arm Volcanics, on either side. The basalt, which is the only occurrence known in the Glass Houses area, has been dated at 93 m.y., much older than the intrusions or the basalt flows of Maleny, to the north.
Stop 5. Scenic Lookout, on the edge of a Landsborough Sandstone escarpment which extends northerly to the east side of Mt Beerwah. The country to the west is part of an old land surface which has been completely removed to the east.

Return to the north-south road through a pine forest and continue south, following the transmission line. At the Woodford turnoff bear left, crossing a trachyte dyke.
Stop 6. 0.4 km farther on, at a road junction, on a rhyolitic dyke, one of several of which radiate from Mt Tunbubudla (The Twins), two intersecting domes of alkali rhyolite to the southwest.

Return to the Caboolture-Beerburrum Road and turn left.
Stop 7. The track up Mt Beerburrum begins about 200 m past the road junction. The fresh porphyritic trachyte is blue-grey and difficult to obtain. On exposure it oxidizes rapidly to a brown colour.
Additional locality: Quarry, north of Mt Beerburrum, reached by a track turning off the main road between the service station and school, Beerburrum. The quarry is in alkali rhyolite which shows steep flow layers. Boulders of weathered porphyritic trachyte from Mt Beerburrum occur in a gully nearby, but the contact is not visible.

17. NOOSA, COOLUM

Features: Landsborough Sandstone, North Arm Volcanics, Noosa Quartz Diorite and its contact rocks, intrusive andesite, granophyre and various dykes, Tertiary basalts, alkali rhyolite.
Route: Via Bruce Highway to Eumundi, Noosa, Coolum, returning to the highway and Brisbane (about 335 km, preferably in two days; if in one day **Stops 2, 4, 5 and 7**).
Maps: Fig. 29, Gympie 1 : 250 000 geological or Moreton Geology map.

Turn off the highway past Mellum Creek to the Landsborough-Maleny Road (for geology this far see Highway Geology.)
Stop 1. Maleny Road, 9 km west of Landsborough, at contact of Late Oligocene basalt with underlying sandstones and shales (Landsborough Sandstone). After examining contact, return to highway or go on to Maleny and Mapleton, rejoining highway at Nambour. The latter route is along the eastern edge of the basaltic plateau, showing good sections through the basaltic flows (red, weathered, vesicular tops and thick red soil on the uppermost flow) and some examples of columnar jointing (e.g. at Mapleton Falls, 4 km by road WSW. of

Mapleton). Zeolite (natrolite) and calcite occur in basalt on the first steep descent from Mapleton.

Stop 2. Highway, 4.5 km past Nambour. An old quarry on the opposite side of the road (beware fast traffic) is in fine to coarse tuffs, bouldery mudflows with some stream channel conglomerates, overlain by brown dacitic ignimbrite, which is best seen in the road cutting to the south of the quarry. These all belong to the Late Triassic North Arm Volcanics.

Stop 3. Eumundi-Noosaville Road. In the first 3 km the route is over andesite (1.1 km) and rhyolitic tuff (1.6-3 km) with rhyolite dykes. Some of the tuffs are

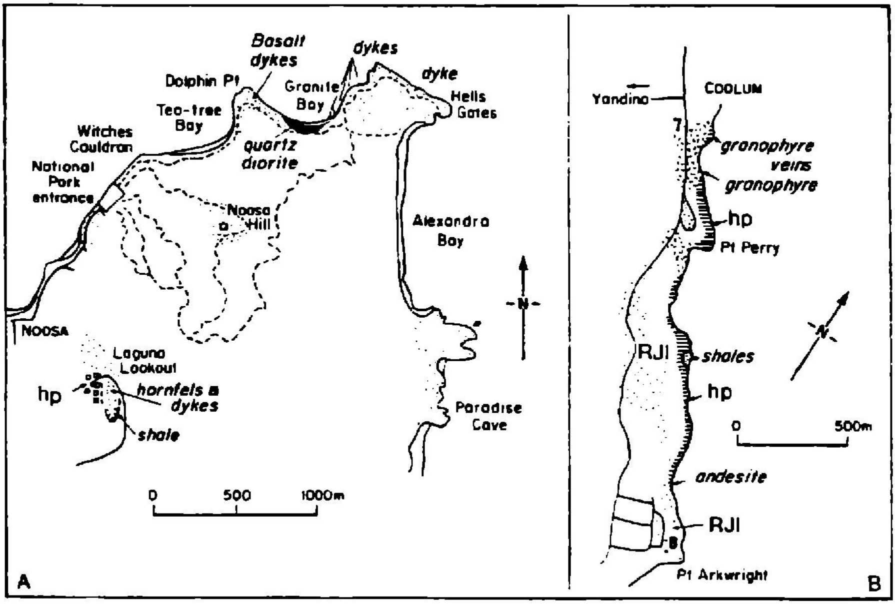

Fig. 29.A: Map, Noosa National Park, showing geological features. B: Geological map of the coastline between Coolum and Point Arkwright. RJl: Landsborough Sandstone; hp: hornblende porphyrite.

almost horizontal with small monoclinal flexures (2.7 km), other occurrences (1.6 km) are vertical. The overlying sandstones, which are correlated with the Triassic-Jurassic Myrtle Creek Sandstone of the Maryborough Basin, are then passed over for a few km before seeing outcrops of andesitic volcanics past Mirrabooka turnoff.

Stop 4. Laguna (Noosa) Lookout, at the end of Viewland Drive. At the top of the old quarry near the lookout, a sill of hornblende porphyrite (with large well-formed hornblende phenocrysts and small amounts of pyrrhotite, (an iron sulphide) has intruded dark shales and siltstones, converting them into a hard, blocky hornfels. An andesitic dyke of much finer grain size than the porphyrite occurs close to the road along the margin of the quarry. The lowest part of the quarry (farthest east from the lookout) has walls of unmetamorphosed shales.

The lookout is a good place to study the geomorphology of the coastal plain and the higher country to the west. The effects of diverting the river mouth to the north and the building of groynes to improve the beach are clearly seen. Some of the hills to the west: Mt Tinbeerwah (trachyrhyolite): Mt Cooroy (fine-grained granitic); Mounts Cooroora and Cooran (alkali rhyolite).

Return to the main road, turn right towards Noosa Heads crossing high sand dunes, then turn right to Noosa National Park (0.8 km along coast).

Stop 5. Parking area, Noosa National Park. A walking track around the shoreline leads to Hells Gates (4 km). For the first 1.6 km the outcrops are mainly of cross-bedded sandstones, correlated with the Myrtle Creek Sandstone. Strong jointing is shown on the wave-cut platform past Witches Cauldron. Between Dolphin Point and the diorite margin, basalt dykes (Fig. 30A) have intruded the sandstones, which have been metamorphosed to quartzite by heat and mineralized waters from the dioritic intrusion. The dykes are vesicular and have been chilled at the margins and offset along joints. A breccia of sandstone and shale close to the diorite contact has probably been formed by faulting before the intrusion of the diorite.

The quartz diorite shows gradational contacts with the quartzite, especially at the foot of the main side track leading to Granite Bay. It is traversed by numerous veins and dykes of aplite and zones containing elongate xenoliths with parallel orientation. Granitic dykes occur to the east of the diorite, and andesitic dykes may be seen near Winch Cove (at low water) and in a depression in the cliff line before reaching Hells Gates.

Stop 6. Mt Peregian, 16 km from Noosa towards Coolum, is a laccolith or domical intrusion of trachyrhyolite containing biotite flakes visible in hand specimen. A quarry on the western side shows vertical columns. Colour zoning caused by diffusion of solutions mimics flow layering.

Stop 7. At the south end of Coolum Beach, the rock outcrops are intrusive andesite (porphyrite), itself intruded by dykes of granophyre close to water level. The dykes follow joints and show evidence of dilation (pushing apart of the joint surfaces). Sloping cliffs of granophyre are seen to the south.

From Point Perry south for 1.5 km, the shoreline outcrops are mainly porphyrite. Xenoliths of hornblende-rich rocks are abundant and there are also

some granitic xenoliths. At one place, a rock platform of dark, hardened shale, forming the roof of the intrusion, dips gently seawards. South of the last porphyrite outcrops a thin andesitic sill has intruded the sandstones, which are faulted against it at its southern limit.

Stop 8. Point Arkwright, about 2 km south of Coolum. Landsborough Sandstone, in cliffs and on rock platforms, includes shale breccias; other features are honeycomb weathering and deposits of iron oxides along joint planes.

Stop 9. Mt Coolum. The mountain is a dome of alkali rhyolite (comendite) similar to the rhyolites of the Glass Houses and of the same age. Vertical columns are present in the quarry (Fig. 30B) but in a cliff above a cave to the southwest, the columns are almost horizontal. Sandstones nearby dip steeply away from the intrusion.

Additional localities: 1. Coolum-Yandina Road, cutting on a ridge between Coolum and Yandina Creeks. The cutting is in North Arm Volcanics, and shows on the north side large irregular masses of altered andesite and tuff interspersed with ignimbrite, the latter showing good eutaxitic structure (flattened pumice fragments with parallel orientation) in a cutting on the old road, south side.

2. Wappa Dam, west of Yandina. Slightly fluidal rhyolite with few phenocrysts, of the North Arm Volcanics, mostly horizontal, but with some flow folds. A green glassy rock has been found at this locality.

3. Cooroy-Tewantin Road. The old road downhill from the Mt Tinbeerwah turnoff is in Mesozoic sandstone with a sill of trachyte or andesite at 0.9 km, and intersecting rhyolitic dykes, one with a chilled margin of pitchstone at 1.75 km. The new road shows complex sections through sandstones, shale and coal with rhyolitic and andesitic intrusions near the turnoff to Mt Tinbeerwah.

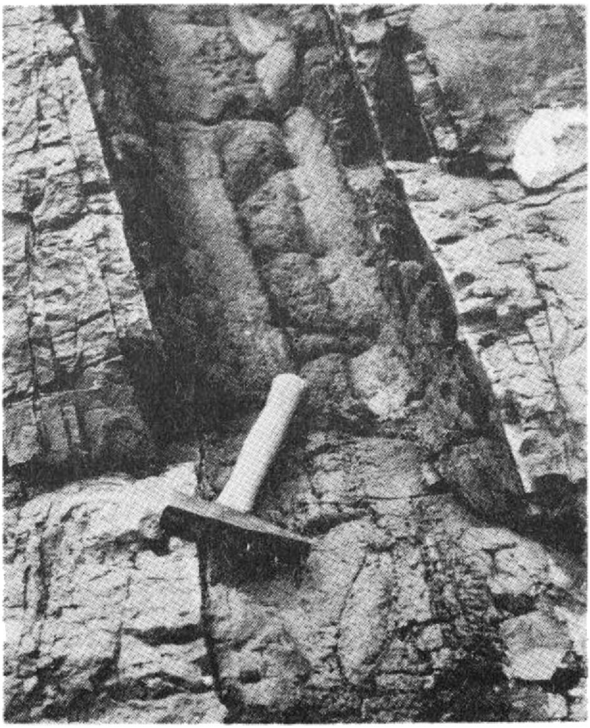

Fig. 30.A: Basalt dyke through sandstone, Dolphin Point, Noosa National Park. Banding due to multiple intrusion. B: Columnar jointing in alkali rhyolite, quarry, Mt. Coolum.

GEOLOGY OF THE BRISBANE VALLEY AND FARTHER NORTH

The upper part of the Brisbane River Valley north of Lake Wivenhoe is the site of the Esk Trough, a narrow north-south structure bounded by faults, with the Palaeozoic North and South D'Aguilar Blocks to the east and the Yarraman Block to the west. In the south, these blocks of metamorphic rocks are separated from the Esk Trough by smaller blocks, the Northbrook Block (to the east) and the Cressbrook-Buaraba Block (to the west), both slices of Permian sedimentary and volcanic rocks bounded by faults.

The major part of the Esk Trough consists of Triassic sedimentary and volcanic rocks:

3. Esk Formation - Shale, sandstone, conglomerate, tuff, coal
2. Neara Volcanics - Andesite, pyroclastics, sediments
1. Bryden Formation - Conglomerate, sandstone, shale, tuff

These formations are probably of Middle Triassic age, older than the formations of the Ipswich Basin. The sedimentary formations contain plant fossils, indicative of a freshwater origin. Dips are generally steeper than in other areas of Mesozoic rocks, and in the Harlin district strong folding is displayed. Several intrusive igneous masses are present including the Late Triassic layered gabbro and granophyre of Somerset Dam and the slightly younger rhyolitic masses of Mt Esk and Crossdale.

Triassic sediments and volcanics of the Esk Trough are covered by Moreton Basin deposits of Helidon Sandstone (Late Triassic-Jurassic) in the south. The belt of volcanics persists north to beyond Gayndah, changing from almost completely andesitic south of Goomeri to a greater proportion of rhyolitic rocks farther north, including ignimbrite sheets of the Aranbanga beds.

Recent mapping by the Geological Survey in the Gayndah district indicates that the Aranbanga beds overlie both the Triassic Gayndah beds (shale and sandstones) and andesitic boulder beds unconformably. The latter may be equivalent to the Neara Volcanics. A fresh-looking basalt, in part porphyritic, is at the base of the sequence.

Tertiary volcanics are mostly some distance west of the Esk Trough except near Murgon, where lateritized basalts cover the trough margin.

18. SOMERSET DAM

Features: Mesozoic sedimentary and volcanic rocks of the Esk Trough, faulted against Palaeozoic cherts, jaspers and basic igneous rocks, serpentinite, Triassic gabbro-diorite-microgranite intrusive rocks.
Route: Brisbane Valley Highway, Splityard Creek Dam, Bryden, Somerset Dam, returning via Esk and Wivenhoe Dam (about 250 km).
Maps: Fig. 31, Caboolture 1 : 100 000 geological map.
Stop 1. 0.4 km along the Bryden Road from the junction with the Brisbane Valley Highway, ferruginous sandstones assigned to the Jurassic Marburg For-

mation show colour zoning. A little farther on, sandstones of the Triassic Toogoolawah Group (not differentiated here into Esk or Bryden Formations) have been tilted by movement close to the Moreton Fault. The next outcrops along the road are cherts of the Neranleigh-Fernvale beds, with some overlying gravels.

Stop 2. 3.6 km from the highway. A cutting on the right shows a well-marked unconformity between the steeply dipping Palaeozoic cherts and almost horizontal gravels with overlying sedimentary breccia. This seems to be a localized occurrence of Triassic beds, perhaps downfaulted into an area of Palaeozoic rocks.

Stop 3. Splityard Creek Dam, Lookout. The rock-fill wall of the dam is largely of a coarse basalt or dolerite, obtained from the quarry seen on the opposite side of the dam. Although quite fresh, the plagioclase has been altered to albite. The rock probably occurs as sills in the Palaeozoic cherts; irregular junctions with them may be seen in several road cuttings in the next 8 km (best at 6.7 km).

Stop 4. 3.2 km from **Stop 3.** Serpentinite outcrops, mainly as the light coloured schistose variety, with pods of dark massive type with lustrous crystals (pseudomorphs after orthopyroxene).

Stop 5. Varley's Hill, 2.3 km past Northbrook Creek rest area. The road passes through a gap in a north-south ridge formed by a thick dyke of dolerite. For the next 0.6 km (downhill), somewhat weathered Permian rhyolites and tuffs showing steep dips, occur in cuttings on the right hand side of the road.

Stop 6. 1.6 km from **Stop 5.** Sandstones, conglomerates and shales of the Bryden beds dip vertically, probably because of proximity to a fault. Plant fossils have been found in the shales. From Bryden, the road passes over Neara Volcanics to Somerset Dam, but better outcrops are seen later.

Stop 7. Second Waterfall Gully. Park at rest area about 1.5 km north of Somerset Dam and walk to Gully. Outcrops of strongly jointed andesites (Neara Volcanics) occur in the gully, with rounded boulders of quartz diorite and microgranite from the Triassic intrusive complex higher up the hill.

Stop 8. On Esk Road, past turnoff to Bryden. Andesite and andesite breccia of the Neara Volcanics. Another cutting in similar rocks is 2.7 km farther on, before crossing the Brisbane River.

Stop 9. 13.6 km past turnoff to Bryden. An excellent exposure of Esk Formation conglomerate capped by a layer of rhyolitic rock, probably a sill despite its vesicular texture. Passing through Esk, the hills to the east are of fine-grained intrusives mainly of Triassic age. The closest point to these (on the highway) is on the southeast side of the town, adjacent to a rubbish tip. For geology on the return from Esk to Brisbane, see Highway Geology.

19. BIGGENDEN, COALSTOUN LAKES

Features: Permian and Mesozoic sedimentary and volcanic rocks, granite with contact metamorphic zone, Pleistocene crater lakes, basaltic cones and valley flows.

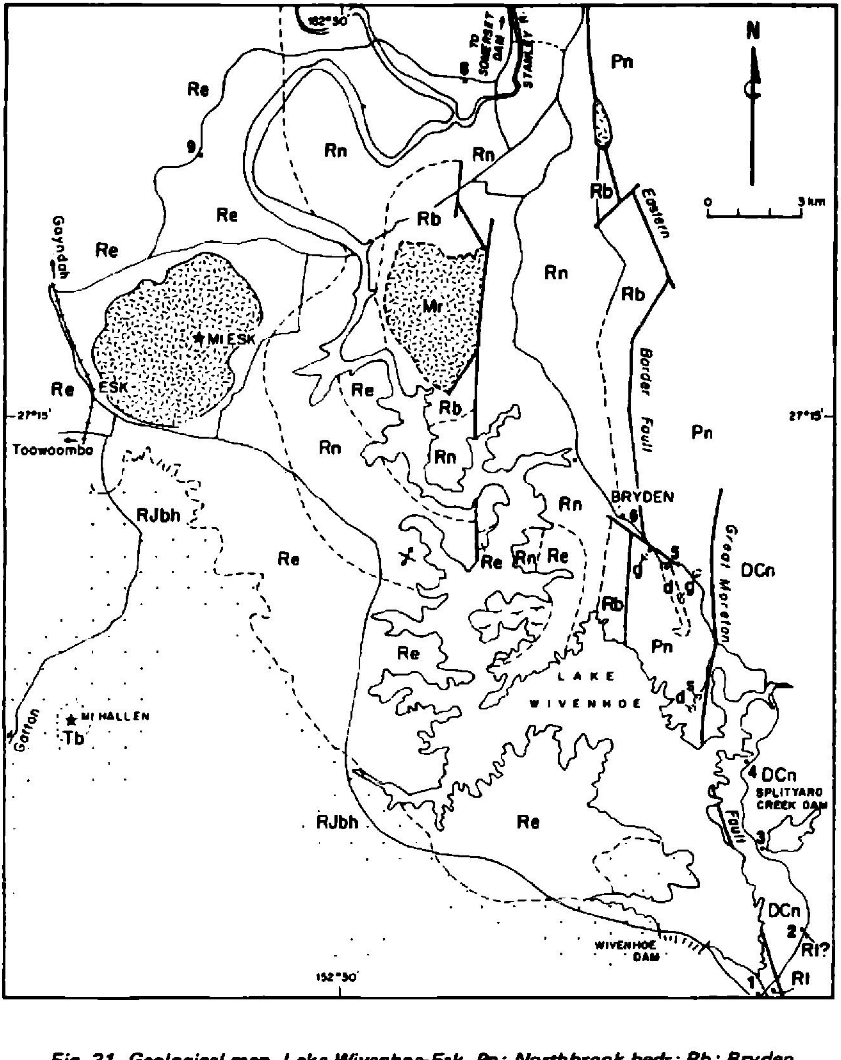

Fig. 31. Geological map, Lake Wivenhoe-Esk. Pn: Northbrook beds; Rb: Bryden Fmn; Rn: Neara Volcanics; Re: Esk Fmn; RJbh: Helidon Sandstone; Mr: Mesozoic rhyolite; Tb: Tertiary basalt.

Route: Gympie, Woolooga, Biggenden, Coalstoun Lakes returning via Brisbane Valley Highway through Esk, or Kilcoy (about 700 km).
Maps: Fig 32, Gympie and Maryborough 1 : 250 000 geological maps.

If the forward trip is to be completed in one day, it is recommended that no geology stops be made before Bells Bridge (Kilkivan turnoff, Bruce Highway); for this section see Highway Geology.

Bells Bridge-Woolooga

For the first 7 km the road passes over Mesozoic sandstones and shales correlated with the Myrtle Creek Sandstone. A cutting in andesite at 9.3 km then outcrops of basalt agglomerate are noticed on the north side of the road. Nearer Woolooga, black shales are followed by poor exposures of weathered granite. The volcanic and sedimentary rocks between the granite and the belt of Mesozoic rocks are of Permian age.

Woolooga-Biggenden

Points of interest, with distances in km from Woolooga, are:

1. (4.0). Granite with tourmaline-rich zones and dykes of non-porphyritic rhyolite, banded at the margins.
2. (14.7). A deep cutting in andesitic rock, probably intrusive.
3. (24.2). Calgoa turnoff. Outcrops of granodiorite, close to the contact with Permian sedimentary rocks, occur just south of the turnoff.
4. (25.0). Entrance road to 'Marodian'. A belt of dipping Permian limestone lies to the east of the main road and about 0.8 km from it.
5. (27.7). The contact of granodiorite and calc-silicate hornfels (originally impure limestone) is shown in a cutting. Small red garnets may be found, also traces of copper minerals. An andesitic dyke of an east-west swarm has intruded the granodiorite. The next two cuttings are in Permian greywackes, somewhat sheared and metamorphosed, and intruded by dykes.
6. (30.6). About 1.6 km past Lilli Pilli Creek, the granodiorite has been intruded by dacitic and andesitic dykes.
7. (37.1) Calc-silicate minerals occur in impure limestone on the right-hand (northeast) side of the road at this point. The Permian limestone belt outcrops for the next 3.2 km along the road, along the strike of the limestone, and is followed by Permian shales and siliceous siltstones.
8. (61.2-61.5). Early Triassic Brooweena Formation sandstones and shales, which overlie the Permian rocks, are well exposed in several cuttings, and continue as far as the level crossing at 68.2 km.
9. (71.9) Permian siltstones and mudstones dip westerly at 45^{o}, and are intersected by strong, nearly vertical jointing and an altered andesitic dyke.
10. A few hundred metres past the previous locality, the Permian strata give place to more gently-folded Triassic conglomerates, sandstones, and shales, outcrops of which are seen for 3.2 km past Mungore Creek.

Approaching Biggenden, Mt Walsh and The Bluff are to the south; these mountains consist of fine-grained siliceous phases of a Triassic granitic batholith.

Biggenden-Ban Ban Springs

1. Magnetite mine, Mt Biggenden. Turn right from the Gaydah Road, 3.2 km from Biggenden. The mines, 5 km farther on, are underground workings and

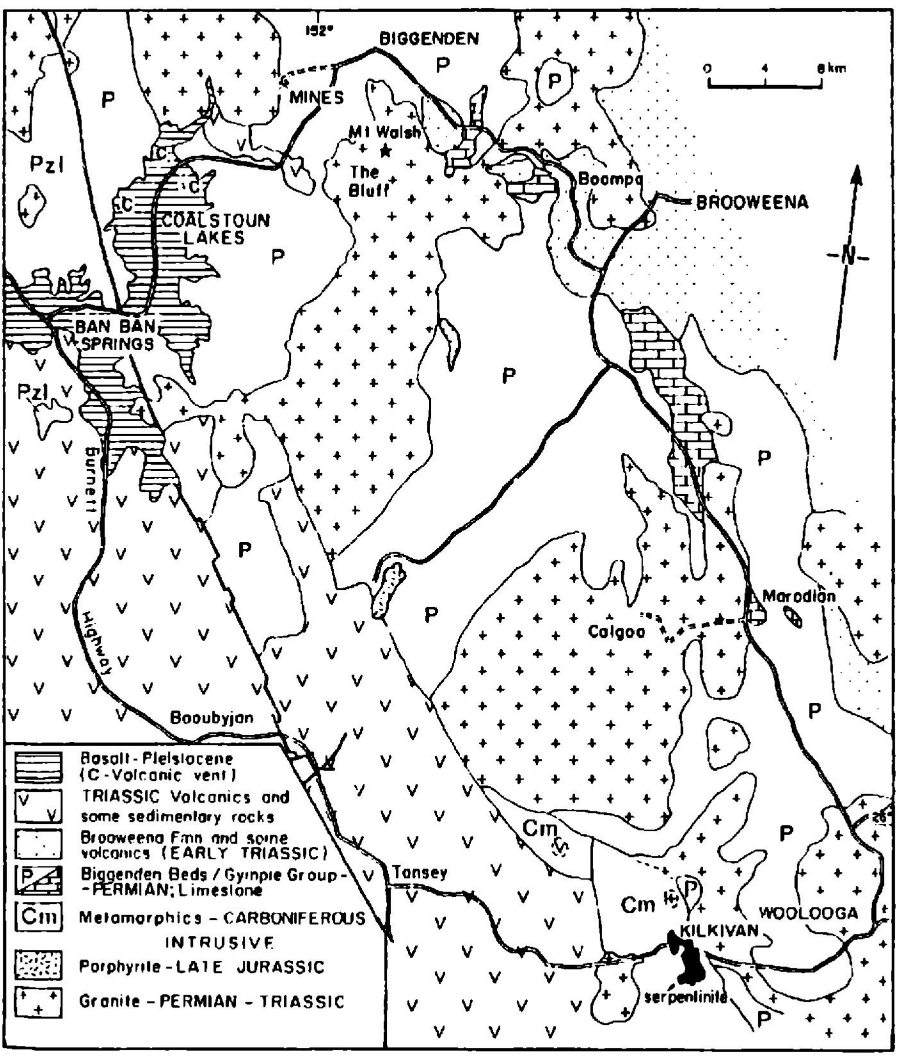

Fig. 32. Geological map, Woolooga-Biggenden.

open cuts in magnetite-calcite rock in the contact metamorphic zone of a granitic intrusion. The intruded rocks were formerly Permian andesitic volcanics and limestone lenses, now metamorphosed to various types of hornfels. The contact between hornfels and granite is at the entrance to the underground workings and on a bench above, where recrystallized limestone and magnetite-calcite rock with actinolite (amphibole) occur. Many other minerals have been found here including bismuthinite. The mine was originally worked for bismuth and gold, but in recent years, magnetite, used in coal washing, has been the important mineral.

The contact zone is extensive; calc-silicate rocks, formerly bedded calcareous siltstone and limestone, may be seen on the way back to the main road, 2.9 km from the mine office.

2. Outcrops of rhyolite on either side of Rocky Creek have been mapped as Aranbanga beds.

3. A cutting 6.2 km past Rocky Creek shows andesitic rocks, including boulder beds and pyroclastics, of probable Permian age.

4. View point, 8.5 km past Rocky Creek. The broad valley ahead has a surface of Pleistocene Barambah Basalt, which emanated from cones nearby. Mt Le Brun (on which the twin crater lakes, Coalstoun Lakes, are situated) is to the left; Harveys Knob, another basaltic cone, is to the north, and another vent, with a breached crater, is to the southwest along the line of hills forming the western margin of the valley. This latter ridge is thought to be the result of silicification of Palaeozoic rocks along a prominent north-south fault.

5. At Coalstoun Lakes village turn left (east) and follow road, curving northerly to National Park boundary overlooking one of the crater lakes (Fig. 33). Volcanic bombs occur amongst the scoria of which the cone is built.

Return to the main road, which is on Pleistocene basalt as far as the next stop except for Palaeozoic siliceous mudstones and cherts at the southern end of the ridge noted under 4 (above).

6. Ban Ban Springs. For details of geology along the highway in either direction see Highway Geology.

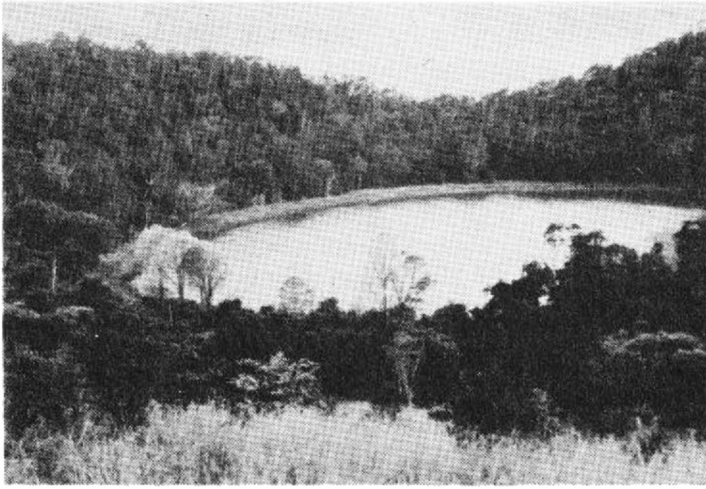

Fig. 33. One of the Coalstoun Lakes (a crater lake).

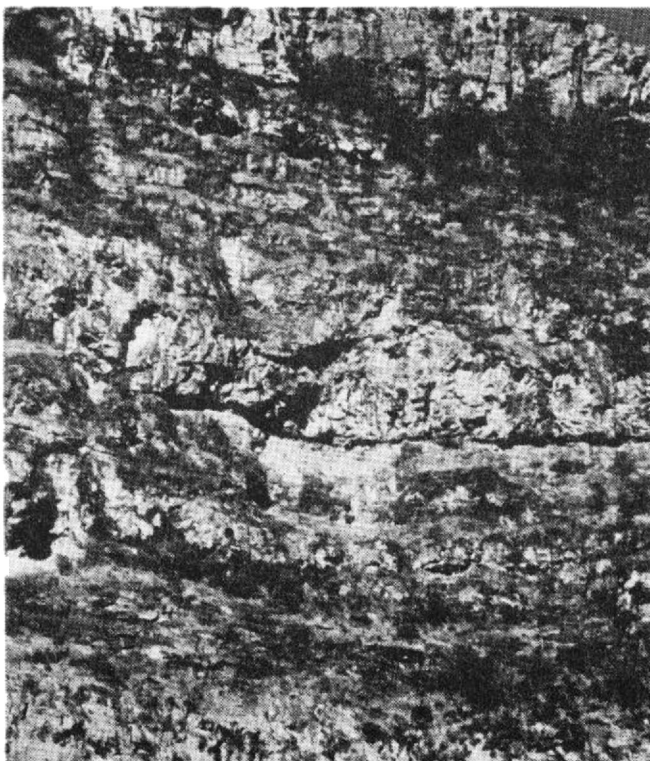

Fig. 35. Basalt flows of the Main Range Volcanics, Mt Mitchell.

GEOLOGY OF THE MAIN RANGE AND AREAS TO THE WEST

In southern Queensland the Main Range and Bunya Mountains are part of the Great Dividing Range, the watershed between coastal streams (tributaries of the Brisbane River and Teviot Brook) and those which flow westerly, into the Condamine River. The ranges are formed from volcanic rocks of Oligocene-Miocene age, known in the south as the Main Range Volcanics.

The eastern side of the Main Range as far north as Hampton is an escarpment caused by erosion; the almost horizontally layered and vertically jointed lavas have been cut back by the active coastal streams flowing for most of their length on the less resistant Mesozoic sandstones and shales, which underlie the lavas. West of the divide, plateaus and ridges slope gently west. The most precipitous country on the western side is in the south, where the highest points (over 1300 m) occur along the divide. In this area the only roads are through 'air gaps' in the range, formerly occupied by west-flowing creeks which rose farther east.

The Tertiary volcanic rocks are largely basaltic types of the alkali olivine basalt suite. They grade through dark coloured pyroxene trachytes into light coloured trachytes, some of which are fragmental (brecciated). The trachytes form distinctive cliffs at The Steamers, Wilson's Peak, Queen Marys Falls and Mt Castle, and are confined to the lower part of the volcanics. With the exception of a fine-grained flow near Cooby Creek, all occur to the south of Toowoomba.

The Bunya Mountains appear to be an eroded shield volcano (from the dome-like form) and are almost entirely of basaltic rocks similar to those of the upper part of the Main Range Volcanics.

The sources of these volcanics is not obvious - most of the basalts probably emanated from dykes and necks some of which are exposed to the east of the escarpment, but many may still lie hidden beneath the lavas. The trachytes probably came from dome-like intrusives, some of which have been revealed by erosion (e.g. Mt Fraser) but except in a few cases, it is difficult to link a particular lava flow with its source.

The layering of the Main Range Volcanics generally slopes at between 1^{o} and 3^{o}, mainly to the west, but in a few places on the larger eastern spurs (e.g. Mt Matheson) the volcanics dip easterly.

The Jurassic rocks which underlie the Tertiary volcanics belong to the Moreton Basin; these pass into formations of the adjoining Surat Basin to the west of Dalby.

The Precipice Sandstone crops out in a sinuous east-west belt around the northern margin of the Surat Basin, seen best in the Carnarvon Range and north-east of Taroom. The abundance of plant fossils and the cross-bedding indicate a stream deposit, probably formed by streams similar to those of the channel country of present-day western Queensland. The Evergreen Formation consists mainly of siltstone, but with shale and sandstone at some horizons. This formation, and the Hutton Sandstone, are equivalent to the Marburg Formation;

Table 3: Sequence in the Surat and Moreton Basins.

	Surat Basin		Moreton Basin
6	Early Cretaceous sediments (Rolling Downs Group)		
5	Jurassic-Cretaceous sediments. (former Blythesdale Group)		
4	Injune Creek Group		
		3	Walloon Coal Measures
3	Hutton Sandstone		
		2	Marburg Formation
2	Evergreen Formation		
		1	Helidon Sandstone
1	Precipice Sandstone		

the Injune Creek Group includes the Walloon Coal Measures, together with formations of sandstones and finer-grained sediments, all of Jurassic age. Late Jurassic to early Cretaceous beds follow, overlain by early Cretaceous marine sediments south of Roma, deposited when the sea entered the Great Artesian Basin from the north.

Tertiary basalts which cap the Carnarvon Range extend south towards Mitchell. Cainozoic sediments over 20 m thick cover about one quarter of the present Surat Basin; they include the Tertiary Chinchilla Sand, and Quaternary old and recent flood plain alluvium.

20. CUNNINGHAMS GAP

Features: Basalts and trachytes of the Main Range Volcanics, various Tertiary intrusions, Jurassic sedimentary rocks.
Route: Cunningham Highway (see Highway Geology) or a longer route from Warrill View and south through Rosevale (some unsealed road) to rejoin the highway at Aratula, giving views of the escarpment north of Cunninghams Gap ('The Ramparts') and Mt Castle (trachyte).
Maps: Fig. 34, Warwick 1 : 250 000 geological map, Warwick 1 : 100 000 map.

Stop at Bell Bird Park past Mitchell Gully on the ascent of the escarpment, to view the section through the lava flows (some with 'red tops') exposed in the cliffs of Mt Mitchell (Fig. 35).

From the car park at Cunninghams Gap (756 m) graded walking tracks on the south side lead to the east peak of Mt Mitchell (1099 m, 5.1 km), and on the north side to the saddle west of Mt Cordeaux (1020 m, 6.4 km).

Both mountains consist principally of olivine basalts including some more properly termed hawaiites. At about 975 m, an amygdaloidal zone rich in the zeolite chabazite indicates an upper margin of a basalt flow; numerous other amygdaloidal and vesicular zones are present, corresponding to margins of flows seen from the road on the approach to Mt Mitchell. Other features to be noted are small lava caves (beside both tracks) which were probably original cavities

beneath the flow surfaces. On Mt Cordeaux, red soil horizons between lava flows are more obvious than on the Mt Mitchell track. A vertical shaft and a cutting (ending against a vertical wall) high up, beside the Mt Cordeaux track, have been quarried out by miners!

The walking tracks to either of the summits give sections through only the upper half of the Main Range Volcanics. The lower half is characterized by several layers of light coloured trachyte or trachyte breccia, and only one of these is seen on the Cunninghams Gap highway section (just below the Gap). At least one additional trachyte can be seen on the Spicers Gap track. (Turn off highway between Aratula and Cunninghams Gap and keep to the right at two intersections. At the second junction the left-hand road goes past Mt Greville, a dome-like mass of alkali rhyolite, to connect with roads to Croftby and Moogerah Dam). The right-hand road to Spicers Gap is trafficable only to the foot of the Range for conventional vehicles.

Trachyte fragments are noticed soon after starting the ascent, but these are probably debris from intrusives or from lavas much higher up. 0.8 km from the foot of the first hill, sandstone has been converted to quartzite adjacent to trachyte, which is probably an intrusion.

A short distance farther on, basalts overlie the sandstone. The most obvious trachyte layers occur where a steep climb is followed by a flat area, as at 3.8 km from the foot of the hill, and again, at the top of the climb (gate and grid) where the trachyte in the old cutting (cliff on right) shows some flow structure and the junction with the underlying basalt. The left fork in the track leads, in a short distance, to Governors Chair, a lookout on trachyte outcrops.

21. QUEEN MARYS FALLS

Features: Basalts and trachytes of the Tertiary Main Range Volcanics, Tertiary intrusive rocks.
Route: Boonah, Croftby, Carneys Creek Road, Boonah Border Gate, The Head-Killarney Road (some rough gravel sections). Return via Emu Vale and Cunninghams Gap (sealed road) or via Mt Lindesay Highway, or via outward route, or down a steep rough track from The Head to Teviot Brook and Boonah.
Maps: As for Excursion 20.

Geology, outward trip: Walloon Coal Measures from the Boonah turnoff (6 km from Ipswich) with few outcrops (except for open cut to left after 2 km). Tertiary volcanoes of Flinders Peak and surrounding mountains are mostly trachyte except for Ivorys Rock (rhyolite and breccia). Beyond Boonah take the road to Maroon for 9 km then turn right on a road to Carneys Creek. Approaching Croftby the ring-dyke of Minto Crags (alkali rhyolite) is passed on the right (lagoon in foreground) and then the high mountain mass of Mt Moon, a domical rhyolite intrusion, with a dolerite sill forming a flat-topped hill at its southern end. At Teviot Brook crossing, the road to the right leads to The Head (and to **Stops 6, 7, and 8**). To ascend the Range it is better to take the Carneys Creek Road (also known as White Swamp Road) straight ahead, as it climbs gradually

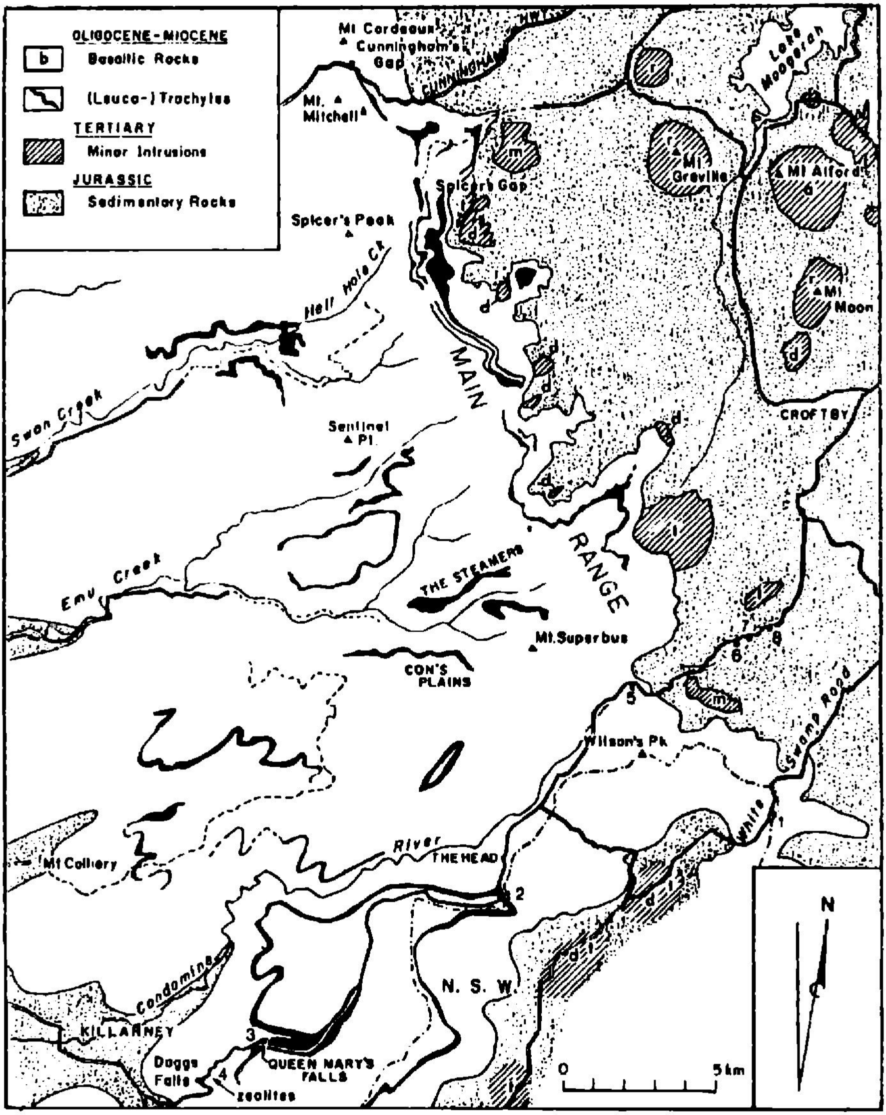

Fig. 34. Geological map of the southern part of the Main Range.

to the border gate (on basalt), passing over a sill of porphyritic trachyte (outcrops by roadside). About 1 km past the gate, white zeolites occur in basalt in a small quarry (**Stop 1**).

About 7 km from the border gate, a road to the right is taken, crossing a sill of fine-grained trachyte and then Jurassic sandstones before turning left to join the road to Queen Marys Falls. After an S-bend on a steep ascent through rain forest, porphyritic basalt with chazabite in amygdules occurs beside the road, and past the parking area for White Swamp Lookout, massive trachyte is seen (**Stop 2**) overlying the basalt. The basal 1.5 m of the trachyte flow is glassy and has flow structure.

For the next 10 km to Queen Marys Falls, the surface is undulating, on top of the trachyte flow.

Stop 3. Queen Marys Falls (National Park). A short walk leads to the Falls and cliff exposures of trachyte, slightly vesicular and somewhat altered.

Continuing towards Killarney, the road descends through basalts which underlie the trachyte. A well-marked, red, weathered flow-top to basalt is shown in a cutting (left side) before the main descent begins. Plentiful chabazite occurs in cavities in cuttings in weathered basalt (on left) just before Daggs Falls.

Stop 4. Columnar basalt at Daggs Falls.

From Killarney, roads to join the Cunningham Highway and Mt Lindesay Highway pass mainly over Walloon Coal Measures with few outcrops (see Highway Geology). The latter road is over more dissected country in which the underlying Marburg Formation sandstones are exposed in river valleys; the former route traverses the western margin of the basalts.

Returning from Queen Marys Falls via The Head:

Stop 5. View of Teviot Falls and landslide at the top of the descent. Basalts continue down the road for only about 0.8 km; the rest of the descent is on Jurassic sandstone (a relatively high base for the lavas of about 600 m).

Stop 6. 1.9 km past the foot of the hill and first creek crossing, rhyolite, probably a sill, outcrops at a gully across the road, and after 250 m (**Stop 7**), cliffs of intrusive microsyenite are on the right. About 1 km farther on (**Stop 8**) an andesitic sill occurs on both sides of the creek.

22. TOOWOOMBA, COOBY CREEK

Features: Main Range Volcanics (olivine basalts, trachytes, tuffs) and laterite, Jurassic sedimentary rocks, silcrete, Permian rhyolite.

Route: Toowoomba, Highfields, Cooby Creek Dam, Hampton, Perserverance Creek Dam, Esk (about 340 km).

Map: Fig. 36, Toowoomba, Oakey and Esk 1 : 100 000 maps.

For details of geology Brisbane to Toowoomba, see Highway Geology.

Stop 1. City Council quarry, Bridge Street, Toowoomba, north of the top of Toll Bar Hill. The special geological interest in this quarry is the presence of bedded tuffs between flows of olivine basalt near the entrance and possible vents

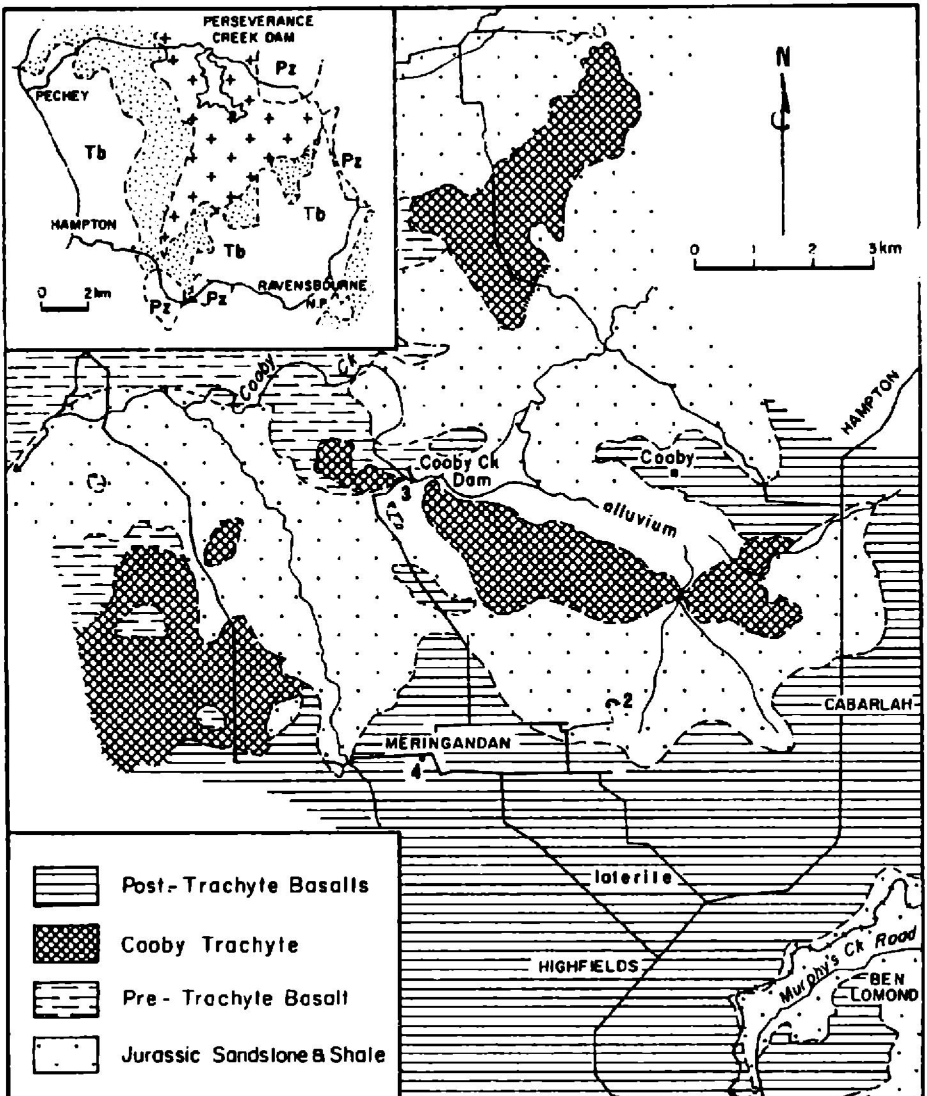

Fig. 36. Geological map of an area north of Toowoomba.

in the eastern wall of the quarry. The northern one has a central area of vesicular brecciated basalt cut by clay-zeolite veins and closely spaced joints parallel to the vent sides, in places with curved surfaces. Adjacent cooling columns become perpendicular to the vent sides as they approach the vent. The southern 'vent' shows only curved joint surfaces and must be considered unproven, as their occurrence elsewhere is not necessarily connected with vent structures.

Take the Crows Nest Road north, passing a railway cutting exposing tuff beds at Harlaxton. Near Highfields and to the north, the basalt surface and some of the underlying Jurassic shales and sandstone (= Marburg Formation) have been lateritized (**Stop 2**, Brickworks quarry at Kleinton). Jurassic sandstone is also seen along the road to Cooby Creek Dam.

Stop 3. Cooby Creek Dam. The spillway, a short walk from the picnic area, is in dense black basalt, showing columnar jointing with variable orientation. This basalt is overlain by a dark coloured trachyte (Cooby Trachyte) which caps the hill to the southwest of the dam and extends downhill towards the caretaker's house. A sloping contact with underlying sandstone was exposed in the road gutter, suggesting that both these lavas are valley-filling flows.

Stop 4. Top of hill east of Meringandan. An altered porphyritic basalt (with olivine changed to iddingsite) forms large, rounded boulders.

Return to the Crows Nest Road and continue northerly to Hampton, then along the road to Esk (alternatively return to Brisbane via Murphys Creek Road, examining tuff interbedded with basalt at the bridge over the railway and olivine in basalt scree from Ben Lomond).

Stop 5. Ravensbourne National Park, off the Esk Road. The Tertiary basalt has flowed over Triassic-Jurassic Helidon Sandstone. The sandstone beneath the basalt has been silicified, producing silcrete up to 2.5 m thick. Caves have been formed by a piping process underneath the resistant silcrete, with removal of loose sand by seepage water. A walking track to the caves is signposted.

Stop 6. 15.6 km from Ravensbourne N.P. turnoff, on the left side of Esk Road. Steeply dipping rhyolite of the Permian Cressbrook Creek Group, showing flow structure.

The route is then over Helidon Sandstone and nearer Esk, over the Esk Formation.

Additional localities: 1. Perseverance Creek Dam, reached via a scenic road north of Hampton. Coarse-grained granite with aplite and pegmatite dykes. The continuation of the road easterly passes through hornfels, and silcrete cappings on sandstone, joining the Esk Road 3 km east of the Ravensbourne N.P. turnoff (the last 10 km is rough gravel).

2. Quarry, near Gowrie Mountain, north of minor road from Highway. Abundant olivine-rich xenoliths in basalt, also vertical columnar jointing.

3. East end of lane off Douglas-Groomsville Road (P, Fig. 36). A glassy phase of the Cooby Trachyte and underlying silcrete.

GEOLOGY OF EAST-CENTRAL QUEENSLAND

The area discussed in this summary lies between Bundaberg and Proserpine along the coast and extends inland to the margin of the Great Artesian Basin. It includes strata of the Bowen, Drummond and Yarrol Sedimentary Basins, the coastal blocks and the Anakie Inlier.

The coastal region between Gladstone and Broad Sound is dominated by rocks of the Curtis Island Group, which resemble those of the Neranleigh-Fernvale beds of southeast Queensland, and are probably of the same age (Devonian-Carboniferous). Arenites, cherts, siltstones and mudstones of this Group dip steeply and show cleavage; some are metamorphosed to schists. The belt continues south from Gladstone inland to Mount Perry and beyond Gayndah. To the west the Group is faulted against other Devonian and Carboniferous rocks, which occur in narrow NNW.-SSE. belts, and include volcanics and fossiliferous limestones e.g. Mt Etna, Marmor. Some of these belong to the Yarrol Basin, which is composed of strata of Middle Devonian to Permian age.

The main outcrops of Yarrol Basin rocks are between Mundubbera and Rockhampton, and a narrow coastal strip extends as far north as Proserpine. In the western part of the basin, the oldest rocks are the Kroombit beds, of andesitic volcanics and sedimentary rocks including a thick bed of fossiliferous limestone containing Devonian brachiopods and corals.

Marine Early Carboniferous strata are widespread in the Yarrol Basin and are characterized by oolitic limestones, as in the Cania Formation and Rockhampton Group.

The Early Permian is represented by thick, mostly terrestrial conglomerates and sandstones (Youlambie Conglomerate) in the western part of the basin, the overlying richly fossiliferous limestones and siltstones of the Yarrol Formation, and the andesitic Owl Gully Volcanics. East and north of Rockhampton a wide belt of volcanics, mainly andesitic with some rhyolites and tuffs, forming the Berserker Ranges is also of Early Permian age.

Ultramafic intrusions formerly rich in olivine, now altered to serpentine, are features of the Rockhampton-Marlborough district. The largest serpentinite mass is about 40 m long and up to 24 km wide. These rocks generally lie along and across a major fault which separates the Yarrol Basin sequence from the Curtis Island Group.

The northern extension of the Yarrol Basin rocks is represented by the Devonian-Carboniferous Campwyn beds, of intermediate and acid volcanics with limestone and other sedimentary rocks, which are underlain by the Connors Volcanics and overlain by Early Permian Carmila beds, of freshwater sediments, tuff and acid volcanics.

Granites of several intrusive epochs, ranging from Carboniferous to Cretaceous, make up the mountainous country southwest and northwest of Mackay. The complex granite batholith is flanked on the western side by andesitic rocks (Lizzie Creek Volcanics) equivalent to the Carmila beds. These are regarded, in this area, as basal deposits of the Bowen Basin, a large structure extending south

to the Theodore and Rolleston districts. Equivalent volcanics in the south are the Camboon Volcanics near Cracow.

The Permian sedimentary rocks which followed the volcanics, the Back Creek Group, were marine, consisting mainly of sandstones, siltstones and mudstones with fossiliferous limestones in the southern part of the basin, but pass laterally into terrestrial coal measures, which are interbedded with marine strata at Collinsville. The upper part of the Permian sequence, called the Blackwater Group, was terrestrial, with important coal deposits at Blackwater, Moura Baralaba and in the Peak Downs area.

On the western margin of the basin, there are no volcanics at the base of the sequence, but large areas of Back Creek Group sedimentary rocks crop out to the northeast of Clermont because of low angles of dip. Farther south near Springsure these rocks occur in anticlinal structures. The Blair Athol coal deposit formed in an isolated basin to the west of the basin margin in the Early Permian.

Southwest of Springsure, thin shelf deposits of the Permian Back Creek and Blackwater Groups and Triassic sedimentary rocks (sandstones, mudstones, conglomerates etc.) form an arcuate belt extending northwest to Jericho and beyond. The Permian strata overlie the Late Carboniferous to Early Permian Joe Joe Group of freshwater sediments, including some of fluvoglacial origin. This in turn overlies folded sedimentary and volcanic rocks deposited in the Drummond Basin during Devonian and Carboniferous times.

Drummond Basin strata are best seen around Bogantungan, and are crossed on the Clermont-Charters Towers Road 200-300 km to the north. On the eastern side, these strata overlie schists and fossiliferous sedimentary rocks of the Anakie Inlier, dated as Ordovician and thought to extend back to the Cambrian Period.

Middle Devonian andesitic volcanics with fossiliferous limestone rest unconformably on the Anakie Metamorphics, and the overlying Silver Hills Volcanics are regarded as Late Devonian and the basal formation of the Drummond Basin. Younger strata, of Carboniferous age, are mainly terrestrial sandstones, mudstones and conglomerates. Extensive areas of terrestrial rhyolites and tuffs (Bulgonunna Volcanics) of Late Carboniferous age unconformably overlie the Drummond Basin rocks on the northeast margin, to the west of Collinsville.

Triassic sedimentary rocks in this region belong to the Bowen Basin sequence. They comprise chocolate-coloured and green mudstones and lithic sandstones of the Rewan Group (Late Permian - Early Triassic), white sandstone of the Clematis Sandstone and mudstones, sandstones and conglomerates of the Moolayember Formation. These are best developed north of the Carnarvon Range but also occur west of Theodore and in the north of the Bowen Basin.

Triassic andesites, tuffs and sedimentary rocks occur as scattered outliers of Muncon Volcanics north of Monto and Many Peaks; at and near the coast, rhyolites of the Agnes Water Volcanics are of similar age and are associated with rhyolitic intrusions and probably granites of the same age.

Jurassic and Cretaceous strata in Central Queensland are mostly confined to the Great Artesian Basin west of Jericho and south of the Dawson Highway, but

there are areas of Jurassic sandstones and shale east and southeast of Biloela (Mulgildie Basin) and Cretaceous volcanic rocks, marine sandstones and coal measures in the Rockhampton district. The volcanics include basalt, trachyte and rhyolite flows with comagmatic intrusives and volcanic plugs, the latter forming a group of low hills to the north of the city.

Tertiary basaltic flows are scattered over wide areas in the Springsure, Clermont, Monto-Biloela and Nebo-Eungella districts. Tertiary trachyte and pyroclastics occur at Cape Hillsborough, and there are numerous rhyolitic intrusives and plugs in the Peak Ranges (northeast of Clermont and Capella) and Minerva Hills (north of Springsure). Tertiary sedimentary rocks, mainly sandstones, are widespread over the surface of the Bowen Basin. Quaternary sands, gravels and alluvium also form a cover over the Bowen and the Drummond Basin rocks.

23. AGNES WATER

Features: Coastal outcrops of Triassic Volcanics, mostly rhyolitic (including ignimbrite) and andesitic.
Access: via Lowmead or Miriam Vale.
Maps: Fig. 37, Miriam Vale 1 : 100 000 map.

The main area of interest is within 2 km of Agnes Water. The first headland is mainly of bedded breccia containing fragments of rhyolite and andesite. Two minor anticlinal axes have been mapped, dips varying from 20^{o} to 45^{o}. These rocks are faulted against a dark brown ignimbrite which makes up the northern tip of this headland. Parallel orientation of white feldspar crystals and elongate rock fragments can be seen. The rock is quite siliceous (71.5% SiO_2) although no quartz is visible in hand specimen. The southernmost exposure of the fault is seen in the cliff adjacent to a small beach where the nearly horizontal ignimbrite is in contact with a vertical pipe containing very coarse agglomerate, which has another contact with breccia. The next exposures to the southeast are greenish-grey sandstones associated with dark shale layers on a rock platform. Silicified plant stems and small tree trunks (some in their growth position) occur in the sandstone and *Dicroidium odontopteroides* has been reported from here. A fault has displaced the sandstones and disconformable contacts exist between breccias and both underlying sandstone and ignimbrite. The southeast block of sandstone and shale is interbedded with tuffs and breccias and is faulted against silicified and epidotized andesite associated with masses of red jasper.

Near the northwest end of Workmans Beach, a fine-grained, grey-green rock is faulted against breccias to the west, and dips under breccias to the east. The rock has flow-layering and resembles an andesite, but has high soda and silica, possibly due to alteration. It is mapped as a trachyte on Fig. 37.

On the eastern side of Workmans Beach, a sedimentary breccia overlies an altered rhyolite, possibly a dome. The prominent headland (an island at high tide) is a banded rhyolitic ignimbrite. To the southeast, rhyolite forms the cliffs, overlying breccias which make up the wave-cut platform. Other rhyolites, including the banded rhyolite of Fence Point, and a similar one at Red Rock to the

south, are thought to be intrusive because of steeply dipping flow layers. Outcrops between headlands north of Fence Point are mainly rhyolitic breccias, those to the south of Fence Point are grey-coloured quartz-bearing tuff or ignimbrite. The same rock occurs at other places to the south (Wreck Rock).

A feature of the wave-abraded outcrops, especially the rhyolites, is the fine surface polish.

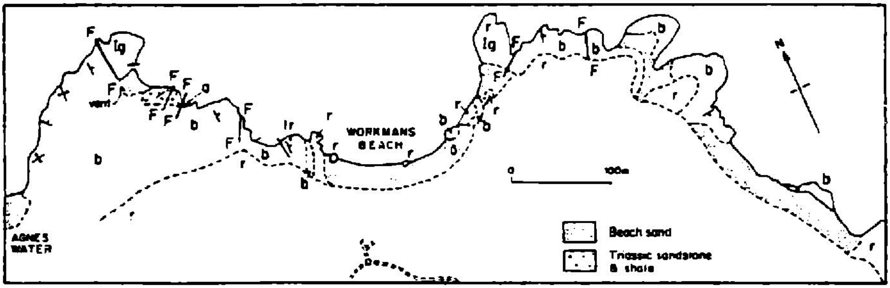

Fig. 37. Geological map, Agnes Water: b: breccia; r: rhyolite.

24. MONTO, BILOELA

Features: Jurassic sandstone cliffs, Triassic and Tertiary volcanics, Palaeozoic sedimentary and volcanic rocks, granite.
Route: Cania Gorge, Coominglah Range, Mt Scoria.
Maps: Monto 1 : 250 000 geological map, Scoria 1 : 100 000 map.
Cania Gorge. Burnett Highway for 12.5 km towards Biloela, then by sealed road for 14 km to Rest Area (camping, drinking water), which is on Three Moon Creek about 12 km downstream from Cania Dam, between spectacular sandstone cliffs.

Several marked walking tracks from the rest area (Two Storey Cave, Dripping Rock and Bloodwood Cave) lead to cliffs of Jurassic Precipice Sandstone, showing jointing and cross bedding. Others start 3.3 km (to Bob Barr's Cave) and 4.5 km (to Streaky Point) north of the Rest Area.

Beneath the sandstone, granite and Triassic Muncon Volcanics outcrop, the latter to the northwest, forming pointed hills west of Cania Dam ('The Nobbies'). Fresh granitic rock, a granodiorite with some xenoliths, occurs as boulders near a road cutting 4.8 km northerly from the Rest Area. The cutting shows weathered granite, cut obliquely to the road by a zone of fracturing and heavy iron oxide deposition.

At 5.5 km northerly from the Rest Area, a gravel road to the right leads after 1 km to an old quarry. A short walk around the Gorge goldfield begins here. (This and other walks are described in a pamphlet obtainable from the caretaker of the Rest Area.)

Pale grey basalts of the Muncon Volcanics near the Dam are found *in situ* on the roadside at the foot of the steep hill just before reaching the Dam, 10.7 km from the Rest Area (stop at Floodway and walk 150-200 m). Similar rocks, used

to form the wall of the Dam, have been obtained from the Spillway area. Medium-grained intrusives outcrop by the roadside 2 km back from the Floodway, opposite sheds on the west.

The Three Moon Creek Road shows micaceous metamorphic rocks in the first cutting, 0.7 km from turnoff, then at 3 km passes over mauve altered basalt with zeolite (views of Nobbies ahead) and at Nobbies Gap (4.5 km), a syncline in bedded tuffs, with overlying altered basalt.

The road between Cania Gorge and the highway passes over Jurassic Evergreen Formation of shales and sandstone (seen in cuttings between 10 and 12.5 km from the Rest Area). On the east side of the Coominglah Range, shales of the same formation have been lateritized, resulting in bright red and mottled red and white soils in cuttings. Although the Precipice Sandstone outcrops in this area, there are no cliffs like Cania Gorge and the highway descends onto the underlying weathered granite, ascending again past 'Coominglah' on to flat-topped areas of Tertiary basalt, which continue to Lawgi Hall. Tertiary sediments (mudstone, shale, sandstone and brown coal) occur beneath the basalt, but do not outcrop well.

Mt Scoria, 6 km from Thangool, an environmental park, is a conical hill of columnar basalt with a talus slope of broken columns and boulders on the eastern side. It is not scoriaceous, and was apparently named because of the shape of the hill resembled scoria hills elsewhere. The climb to the top is up the talus slope. At the top, long columns project in all direction and produce bell-like sounds when struck with a hammer. The basaltic hill is probably an intrusive, and one of the sources for the very similar basalt flows only 3 km away to the east and west. Erosion has severed the connections between the vent and the flows.

Returning from Biloela by the Dawson Highway, the Triassic Callide Coal Measures (sandstone, conglomerate, shale, siltstone, coal) are crossed between Callide Creek and the Callide Range, and then the Permian Youlambie Conglomerate (here mainly tuffs) to Collards Creek, which is faulted against Early Carboniferous strata outcropping to the east along Collards Creek.

25. ROCKHAMPTON, CAPRICORN COAST

Features: Trachytic intrusions into the Palaeozoic Curtis Island Group (similar to the Neranleigh-Fernvale beds of southern Queensland), serpentinite, Late Cretaceous trachyte plugs northwest of Yeppoon, Carboniferous and Permian sedimentary and volcanic rocks.

Route: Berserker Range, Emu Park - Yeppoon round trip.

Maps: Fig. 38, Rockhampton 1 : 250 000 geological map and 1 : 100 000 map.

Stop 1. Mt Archer. Panoramic view of the Rockhampton district, including Cretaceous plugs, in a group to the north. On the descent, interbedded siltstone and tuff, also some andesitic volcanics, of the Berserker beds may be seen.

Stop 2. Southeast of Lakes Creek. Fossiliferous siltstone in the Berserker beds occurs in a small quarry on the north side of the road (take first gravel road on left after crossing railway on main road and follow it for about 200 m; quarry is

on the left). Brachiopods, bryozoa and molluscs are the predominant fauna of the Berserker beds.

Stop 3. Emu Park. 'The Singing Ship' Memorial. On the rock platform to the north, trachyte, in a sill-like mass, weathered to a brown colour, intrudes Wandilla Formation argillites, with layering dipping northeasterly. A dyke is marked by a fissure in the rock platform. It is offset, and is also seen on the hill on which the memorial stands.

Stop 4. The Causeway, north end. A short walk to the sea coast brings one to another trachyte intrusive, dipping seaward again, with well-developed columns and honeycomb weathering. These features are seen to better advantage along the beach to the north. A cleft in the rocky hill leads to a mass of Palaeozoic brecciated chert which is on the underside of the trachyte sill. The contact is exposed on the northern side of this fissure, which may have been produced by faulting or strong jointing.

Stop 5. North end of Mulambin Beach. Proceeding from this point around the headland, boulders of altered 'porphyrite' with white feldspars, loose and cemented with smaller fragments, give place to highly jointed brown trachyte, *in situ* then to Palaeozoic metasediments with limonite along joints and thin sills of steeply dipping trachyte.

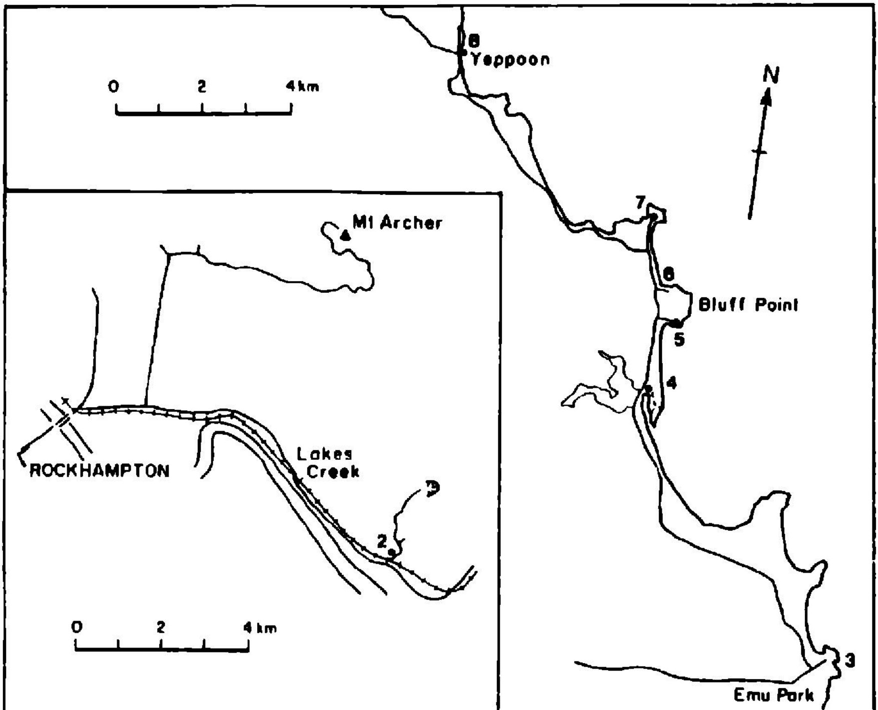

Fig. 38. Map of Rockhampton area and the Capricorn Coast.

Stop 6. Bluff Point National Park, south end of Kemp Beach. A track leads to an outstanding viewpoint, towards Double Head (to the north). Bluff Point is composed mainly of a trachytic intrusive, and its contact with the Palaeozoic rocks can be seen at water level by walking along the rock platform towards a cliff which blocks further access. The steep-sided edge of the trachyte forms a cliff at the edge of the rain forest, with columns at right angles to it.
Stop 7. Rosslyn Harbour. A very good exposure of the dipping trachyte mass, with sloping columns, is opposite the ferry terminal. Caves in the trachyte are just above ground level. Cliffs at the south end of the headland, accessible over a rock platform from the entrance to the N.P.W.S. offices show highly jointed Wandilla Formation close to the road and trachyte farther out. The junction between them may be a faulted one. Variable dip of the trachyte columns is exhibited in a concavity in the cliff.
Stop 8. Yeppoon. Contorted cherts like those found in the Palaeozoic rocks near Brisbane are exposed in a cutting and on the beach side of the road 200 m along the Byfield road from the Hotel corner.

The return trip to Rockhampton passes Mt Jim Crow, one of a group of Cretaceous alkali trachyte plugs, best viewed from a few km along an unsealed road to the right (towards Barmoya) after passing Mt Jim Crow. A track along Hedlow Creek passes the western side of Mt Hedlow, a steep-sided plug.
Additional localities: 1. Mt Hay, 41 km west of Rockhampton. Trachyte and rhyolite which form two separate plugs and associated volcanics have been assigned a Cretaceous age. A 'gemstone tourist park' allows the visitor to fossick for agate and thunder-eggs (spherulites with radiating feldspar margins and glass or silica cores).
2. Limestone caves (Olsen's Caves, Cammoo Caves) about 30 km by road (Bruce Highway to The Caves) north of Rockhampton, are in Devonian Mount Holly beds. Many different coral species have been recorded from the Mt Etna limestones, including ***Acanthophyllum*, *Calceola*, *Rhizophyllum*, *Phillipsastrea*, *Radiophyllum*, *Pseudamplexus*** and ***Tryplasma***.
3. Gracemere. Quartz gabbro, showing foliation, has been quarried here for building stone.

26. MACKAY, HIBISCUS COAST

Features: Devonian-Carboniferous and Permian sedimentary and volcanic rocks (Campwyn beds and Carmila beds), granite, Tertiary volcanic rocks and intrusives.
Route: Bruce Highway to Yakapari, thence to Seaforth, Hallidays Bay and Cape Hillsborough.
Maps: Mackay and Proserpine 1 : 250 000 geological maps, Mackay and Calen 1 : 100 000 maps.
Stop 1. Finlaysons Point. Turn off the Seaforth-Port Newry road onto a gravel road to the right, and continue along the coast. Folded and strongly jointed siltstones and tuffs of the Campwyn beds are exposed on the rock platform.

Some fossils have been reported (the Campwyn beds contain a Late Devonian-Early Carboniferous fauna of brachiopods, corals and pectens). At low tide it is possible to walk along a sand and gravel causeway to the Redcliffe Islands, where plunging folds, faults and a natural bridge are the main features.

Stop 2. Hallidays Bay. The headland close to the caravan park is composed of dipping beds of calcareous siltstone overlying a sandstone or tuff with silicified limestone beneath, accessible at low tide. The siltstones show well-developed cross-beds and lenticular beds; some former fossils (or ?concretions) occur in the sandstone or tuff (which has gravel bands), and there are possible fossils in the basal limestone, but all the beds appear to have been somewhat metamorphosed. Following the coast around to the west, the rocks are sandstones or greywackes containing many coarse fragments, and some epidote veins with a faulted dyke and a ?sill in sandstone below the siltstones. On the headland to the east of Hallidays Bay, granite outcrops with strong joints dipping seawards. The granite is thought to be Cretaceous in age. It contains some fine-grained, rounded xenoliths.

Stop 3. Ball Bay, for a view of the horizontal Tertiary volcanics (trachyte, trachyandesites, and breccias) of Cape Hillsborough. The road to Cape Hillsbrough passes Pinnacle Rock, a trachyte plug thought to be related to the Tertiary lavas.

Stop 4. Cape Hillsborough (National Park). From the picnic area, a walk along the beach is past fallen blocks of volcanic breccias, some bedded, derived from the cliffs. Wedge Island, to the south, is of basalt.

Stop 5. Lookout, view of Mt Jukes (on return from the coast to Yakapari). The main mass of the mountain is granophyric syenite or alkali granite; it is surrounded by a circular zone in which only a few very weathered outcrops of plutonic rock occur (?granodiorite and gabbro). Outside this zone is a ridge of hornfelsed Permian sedimentary rocks, which merges to the south with the granophyric rock of Mt Blackwood.

Additional localities; **1.** Eimeo. Andesitic lavas with some bedded sedimentary rocks (siltstones) dip to the west on the north side of the headland and east on the southside.

2. Grasstree Beach, north end. The headland is composed of dacitic tuffs and conglomerate of the Campwyn beds, intruded by dacitic stocks and numerous dykes of andesite. The headlands on either side of Mick Ready Beach to the north are of similar rocks, but with diorite intrusions.

3. Sarina Beach. The headland at the south end of the beach is made up of dark grey-green breccias of the Campwyn beds. Similar rocks at Campwyn Beach include a limestone lens and fossils (a stromatoporoid and various corals).

GEOLOGY OF NORTHEAST QUEENSLAND

The oldest rocks in this region are metamorphics of Proterozoic age, occurring in several inliers, the largest of which, the Georgetown Inlier, liest to the northwest of Charters Towers. The Georgetown Inlier is divisible into three parts: the western, mainly of ignimbrite sheets (Croydon Volcanics) is younger than the central and eastern parts, which show some variation in metamorphic grade and are separated by a wide mylonite zone. The main rock types in the central and eastern parts are schists, amphibolites, gneisses and greenstones, with some phyllites and serpentinite. Granitic batholiths ranging from Proterozoic to Permian have intruded the metamorphics.

The rocks of the other inliers to the north are similar to those of the central part of the Georgetown Inlier. Greenstones are present in some areas with hematite-quartz schist and magnetite quartzite at Iron Range.

Palaeozoic strata of the Hodgkinson Province (or Basin) are faulted against the east side of the Precambrian inliers and are found in the coastal and highland regions between Cooktown, Chillagoe and Innisfail. The Province contains a thick sequence of marine clastic sedimentary rocks, the Hodgkinson Formation, mainly of Devonian age, overlying the Late Silurian to Early Devonian Chillagoe Formation along the western margin. The latter formation consists of greywacke, quartzose sandstone, arkose, shale, limestone, basic volcanics, chert and conglomerates.

The Hodgkinson Formation, of greywacke, siltstone, shale, slate, greywacke conglomerate, minor (mainly basic) volcanics, chert and rare limestone, has been strongly deformed, and grades to the south into the Barron River Metamorphics. The latter are faulted against a narrow coastal strip of Barnard Metamorphics, comprising schists, gneiss, granitic and altered gabbroic and ultramafic rocks and migmatite, of unknown age.

Near the southern termination of the Hodgkinson Province and extending inland to the Hughenden-Mt Garnet Road, another province of Palaeozoic rocks (Broken River Province or Embayment) comprises strata of Ordovician to Carboniferous age.

The Ordovician formations are made up of quartz-rich greywacke, shale and siltstone, with localized limestone and andesitic members. Silurian and Devonian formations comprise greywacke, shale, siltstone and limestone, including some beds with a rich fauna of corals, brachiopods, conodonts etc.

The Early Carboniferous Clarke River Formation overlies earlier strata with angular unconformity; rock types are sandstone, conglomerate, siltstone, mudstone and rare limestone and tuff. Similar rocks are present in the Bundock Creek Formation farther west, but the lower strata extend down into the Devonian.

At the southern margin of these Palaeozoic Basins an east-west granitic area known as the Lolworth-Ravenswood Block separates the northern basins from the Drummond Basin. The batholiths are composite and although ages from Ordovician to Devonian have been determined isotopically, parts of the batholiths may be older.

The Burdekin Basin strata rest unconformably on the Lolworth-Ravenswood Block. They are of Devonian to Carboniferous age and began to be deposited in the Late Middle Devonian, with the formation of arkose (at the base of the Fanning River Group). Thin-bedded limestone, calcareous shale and a sandstone-shale sequence followed. The Dotswood Group, of sandstone, conglomerate and red shale, and the Keelbottom Group, also of clastic sedimentary rocks, complete the basin deposits. During the early part of the Carboniferous Period, earth movements uplifted the Townsville hinterland and slightly warped the Devonian-Early Carboniferous strata. The Oweenee Granite may have been intruded at this time. Marine deposition ceased, but sedimentation recommenced during the Middle and Late Carboniferous, with the eruption of acid and intermediate flows and pyroclastics.

The various occurrences are concentrated in a NNW.-trending belt, extending northerly from the Bulgonunna Volcanics near Mt Coolon, through the scattered occurrences west of Townsville, Ingham and Tully, the Glen Gordon Volcanics near Ravenshoe, to the Nychum Volcanics NNW. of Chillagoe, and the extensive area of Featherbed Volcanics to the east.

Within the Georgetown Inlier, volcanics of similar age and rock types are widespread, associated with ring-dyke complexes. The largest area is covered by Newcastle Range Volcanics, in a north-south belt east of Georgetown and Forsayth. Most of these rocks are rhyolitic ignimbrites.

Fault-bounded outliers of Permian strata occur north of the Palmer River (Little River Coal Measures), at Mt Mulligan to the northeast of Chillagoe, and at about 30 km west of Cooktown. The only other Permian strata in this region are to the northwest of Pentland and in Galah Gorge, where conglomerate is overlain by siltstone and mudstone with coal seams. These are overlain by the Warang Sandstone of the White Mountains area, correlated with the upper part of the Clematis Group and the lower part of the Moolayember Formation of the Bowen Basin. The Permian and Triassic of this area belong to the Galilee Basin, most of which is buried beneath Jurassic and Cretaceous strata of the Eromanga Basin.

Jurassic and Cretaceous sedimentary rocks make up the Laura Basin west of Cooktown as well as the Carpentaria and Eromanga Basins, the northern part of the Great Artesian Basin west of the Georgetown and Coen inliers and the Lolworth-Ravenswood Block.

The Jurassic sedimentary rocks are mostly quartzose sandstone with conglomerate, siltstone and shale; Cretaceous strata belong to the marine Rolling Downs Group, previously mentioned from inland southern Queensland. In general, these are of finer grain size and are more calcareous than the Jurassic strata.

In northeast Queensland, several volcanic provinces are recognized, composed entirely of basaltic materials. Most ages determined isotopically are in the Pliocene and Pleistocene Periods and include the youngest volcanism in Queensland.

Apart from Quaternary pyroclastic cones and basalts on islands in Torres Strait and a plug near Coen, the most northern provinces are in the Cooktown

district near Hopevale and Lakeland. Better known is the Atherton Province, a basaltic tableland with deep red soils. The province shows a variety of volcano types including lava shields, cinder cones, at least 6 maars and a diatreme (Hypipamee Crater). Flows from the tableland poured down gorges in the escarpment (e.g. North and South Johnstone River Gorges) towards the coastal plain.

A large roughly circular province about 80 km across lies to the southwest of the Atherton Tableland. It is called the McBride Province and is characterized by lava plains, broadly domed, with numerous cones. The lavas have flowed away from the central area in all directions; some have travelled long distances. Two branches of a system of lava caves are known, extending up to 70 km from the central (Undara) crater. The youngest vent is Kinrara Volcano with its well-preserved crater, collapsed lava tubes and ropy surfaces of the lavas.

The Nulla Province is west to northwest of Charters Towers. Several flows have been recognized, mostly between 5 and 1 m.y. in age, but the youngest flow, the Toomba flow, with surfaces similar to Kinrara lavas, might be as young as 13 000 years.

The Chudleigh and Sturgeon Provinces are north of Hughenden and are traversed by the Kennedy Highway. Both comprise older basalts, about 4 m.y. old, and younger centres of eruption. Some long flows developed, such as one which travelled 80 km, down the Einasleigh River.

The Chudleigh Province is notable for ultramafic xenoliths (especially peridotite) and crystals of high-pressure origin including olivine, pyroxenes, amphibole, mica, alkali feldspar, spinel and corundum. Several small lava tubes are known near 'Black Braes'.

Numerous small areas of Cainozoic basaltic rocks occur outside these provinces e.g. intrusives near Mingela and in the Ingham district (Mt Fox).

Tertiary sediments underlie the lavas in several places on the margins of the Toomba flow and diatomite has formed in lakes formed by damming of rivers by basalt flows near 'Valley of the Lagoons'.

27. CHARTERS TOWERS, GREENVALE

Features: Precambrian and ?Early Palaeozoic metamorphic rocks, Palaeozoic sedimentary and volcanic rocks including fossiliferous Middle Devonian limestone, granitic-dioritic rocks ranging from Ordovician to Carboniferous in age, rhyolitic intrusives, laterite and Pliocene-Pleistocene basalts.
Route: Flinders Highway to Charters Towers, Gregory Highway to The Lynd junction.
Maps: Fig. 39, Townsville, Charters Towers, Clarke River, Einasleigh 1 : 250 000 geological maps, road maps.

Travelling south from Townsville, the Flinders Highway passes Mt Stuart on its eastern side. Mt Stuart is made up of an intrusive complex of medium-grained rocks ranging from microdiorite to granophyre, with Permian and older volcanics

and sedimentary rocks on the eastern foothills. Details of an excursion to the summit are given in the Excursions Handbook, Third Australian Geological Convention, Townsville, 1978.

The first hilly section of the road past Calcium passes over Devonian sedimentary rocks and granite and farther outcrops to the Burdekin River belong to the Early Palaeozoic Ravenswood Granodiorite complex.

Stop 1. Burdekin River Bridge, east side, Macrossan. Hornblende-rich dioritic rocks of medium to coarse grain size, with some pegmatitic veins are in and close to the river, with gneissic granite upstream.

At Charters Towers on the northwest margin of the Ravenswood Granodiorite complex, the granitic rocks are somewhat altered; specimens of diorite and hornblende porphyrite from dykes can be seen on mullock dumps. Metamorphosed older sediments, now spotted hornfels, occur at Rotary Lookout **(Stop**

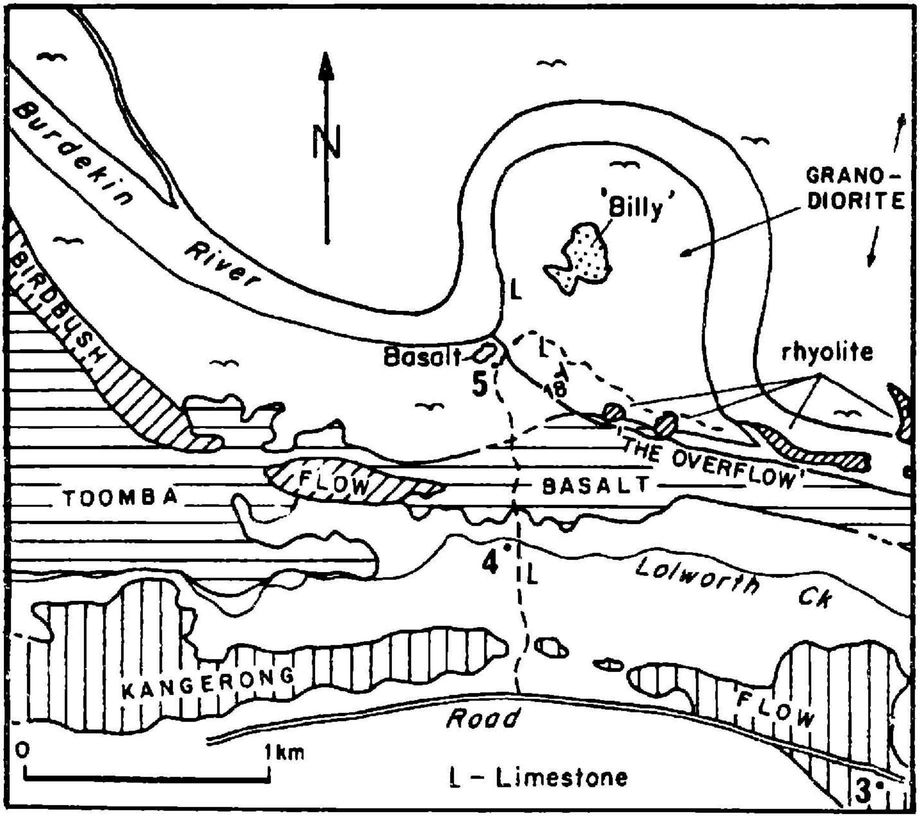

Fig. 39. Geological map of the Big Bend area, Burdekin River.

2), on the northeast side of the town, and diorite occurs to the north of the lookout.

From Charters Towers, the Gregory Highway passes over granodiorite, low-grade metamorphic rocks and lateritic soils as far as Big Sandy Creek (Hann Creek), then onto Pleistocene basalt.

Stop 3. Cutting about 8.7 km past Hann Creek, and nearly 30 km from Charters Towers, where the road rises over the edge of the 'basalt wall' (the Kangerong flow, 2.3 m.y.).

1.5 km farther on, a track to the right leads to the Big Bend area of the Burdekin River, first descending from the basalt surface to cross Lolworth Creek.

Stop 4. Lolworth Creek. Middle Devonian fossiliferous limestone on the south bank of the creek contains rugose and tabulate corals and stromatoporoids. Cystimorphs, *Alveolites, Daniophyllum* and an occasional *Calceola* have been reported.

After the creek crossing, the track rises to the surface of the younger Toomba Basalt flow (13 000 years), with dome-shaped surface structures on the left side of the track and on the river bank ahead. These appear to be lava tongues which have split along their length after subsidence on either side.

Stop 5. Burdekin River. Dipping limestone beds with silicified fossils outcrop on the river bank a hundred metres or more downstream, and if the track is followed over the irregular sandy area, it leads to well-bedded limestone with better preserved fossils on the right. 400 m farther on, diverging to the right from the main track, outcrops of rhyolite make a rocky bar between two wide, deep pools. This channel is called The Overflow. The rhyolite shows deep potholes eroded by pebbles in eddy currents, and columnar jointing. A gentle dip for the intrusion can be confirmed in an outcrop close to a vehicle track nearby, where platy rhyolite overlies bedded arkose. A cliff of Toomba Basalt is on the far side of the downstream pool, and may be examined by crossing the rhyolite bar. Original surface structures (flow wrinkles and ropy structure) are well preserved and the surface is glassy in places. The limestone and the underlying arkose rest unconformably on the Ravenswood Granodiorite Complex, members of which occur along the river bank around the Big Bend, downstream from the limestone near **Stop 5**. Composite dykes, epidote veins and xenoliths are features of the granodiorite in this area.

Northwest from the Big Bend turnoff, the main road continues over or close to the Kangerong flow for about 9 km to the turnoff (left) to Red Falls and Toomba. At Red Falls, 41 km from the turnoff, two lateritic profiles are present, the older is the scarp of the falls, a 1-2 m zone of red-brown laterite with abundant potholes, passing down into mottled and pallid zones. The younger profile is above a cliff-line of white Tertiary sediments (Campaspe beds), and the overlying Toomba Basalt is on the northern side of the creek.

Stop 6. On the main road at Fletcher Creek both the Birdbush basalt flow (1.2 - 1.4 m.y.) and the Toomba flow can be seen. Past this point, flat country is underlain by laterite, and is followed by hills in Oweenee Granite. At about 135 km from Charters Towers, the intrusive is a pink porphyritic rock. Some fluorite has been found in this phase.

Stop 7. Clarke River. Slaty rocks of the Silurian-Devonian Kangaroo Hills Formation outcrop in the river bed with layers of conglomerate showing large-scale cross bedding.

A bluff of limestone is passed about 15 km past Clarke River, on the right. It belongs to the Perry Creek Formation which is mostly sandstone and siltstone, conformably overlying the Kangaroo Hills Formation. Greywacke, shale, chert and jasper of the Silurian Wairuna Formation are exposed in Gray Creek.

The Greenvale nickel deposits are in lateritized serpentinite 6 km from the main road; serpentinite is found in road cuttings (main road) 1 km west of Greenvale (**Stop 8**) with veins of magnesite and with overlying red soil. Cuttings 3 km and 4 km past Greenvale are in phyllites and quartzites of the Judea beds and Paddys Creek Formation, superficially similar, but the former is probably Silurian whereas the latter belongs to the Proterozoic of the Georgetown Inlier, as do the Lucky Creek Metamorphics (phyllite, chlorite schist, meta-andesite and quartzite, seen in cuttings east of Lucky Creek, 25 km from Greenvale).

Large outcrops north of the road 45.5 km from Greenvale resemble rhyolite, but are reported to be mylonite derived from a granitic rock. More metamorphics (schist and amphibolite) with foliated granite and pegmatite are exposed in a cutting 48.5 km from Greenvale. These have been mapped as Proterozoic Einasleigh Metamorphics.

If time permits, the excursion may be extended past The Lynd to Einasleigh and Mt Surprise.

In the Einasleigh River, about 1 km northeast of the town, excellent outcrops of Einasleigh Metamorphics (gneiss, migmatite, amphibolite) show evidence of several phases of folding. An old copper mine is situated on the western bank above the river. A porphyry dyke makes high hills of the Caterpillar Range above the river's east bank. Closer to the town (east of the hotel) the Copperfield River is a good place to view the Quaternary basalt which has flowed down both river valleys.

For more detail on excursions in this area, see the Excursions Handbook, Third Australian Geological Convention, Townsville, 1978.

Mt Surprise is near the western margin of the McBride Basalt Province of Pliocene-Pleistocene age. The main geological interest in this district is the basalt 'wall', a long continuous ridge, apparently a former lava conduit, which is intersected on the Georgetown Road 8 km west of Mt Surprise (where the basalt overlies pegmatite and muscovite granite) and crossed over on the track to O'Brien's Creek topaz field.

28. INNISFAIL, ATHERTON TABLELAND

Features: Silurian-Devonian Hodgkinson Basin sedimentary rocks, Barnard Metamorphics, Palaeozoic granite, Quaternary basalts, crater lakes, maars and vents.

Route: Bingil Bay, Palmerston Highway to Millaa Millaa and Ravenshoe, Atherton, Lakes Barrine and Eacham.

Maps: Atherton and Innisfail 1 : 250 000 geological maps, Innisfail, Tully, Ravenshoe, Atherton and Bartle Frere 1 : 100 000 maps or road maps.

Stop 1. South end of Bingil Bay. The rock platform to the south consists of folded, metamorphosed sandstones and shales (Barnard Metamorphics) with lenticular pegmatites of metamorphic origin, cut by two basaltic dykes. Similar rocks occur north of camping sites at the north end of the Bay.

Stop 2. Pin Gin Hill, at the junction of the Palmerston Highway and a road from the Bruce Highway through South Johnstone. A basaltic cone without a crater, it is surrounded by a flow of probably Pleistocene age (0.78 m.y.)

Stop 3. Crawfords Lookout. View of the North Johnstone River. The Highway follows a ramp between the North and South Johnstone River gorges, built of lavas which flowed into an earlier gorge. Later basalts outcrop in the bed of the present gorge upstream from the bend seen from the lookout and form a continuous sequence 300 m thick. The gorges have been cut in bedrock slate and quartzite.

A track leads from Crawfords Lookout down into the gorge and climbs to the highway after 5 km, but little geology is seen along the track, and it is better to proceed 1.8 km from the Lookout to **Stop 4** (K tree site) and follow the track starting opposite for several hundred metres to a series of waterfalls (Tehupala Falls, 400 m, Wallacha Falls, 800 m) in the older basalts. Columnar jointing is well-developed in the relatively thin flows, which contain some zeolite.

The road climbs steadily over basalts, with some underlying granite exposed at the Beatrice River. Approaching Millaa Millaa, several small, well-eroded cones are passed. Millaa Millaa Falls are in columnar basalt, as are Millstream Falls, west of Ravenshoe.

Stop 5. The Crater (Hypipamee Crater), a few hundred metres west of the Kennedy Highway northwest of Millaa Millaa. This is an explosion pipe or diatreme with no erupted material close to the rim. Vertical walls of granite surround a crater lake 56 m deep (68 m below lookout). Basaltic bombs with granite inclusions have been found some distance away from the crater. The vent was drilled by gas pressure.

Stop 6. Bromfield Swamp, on a minor road to Malanda, is at the centre of a large crater or maar, breached at its eastern rim.

Stop 7. Lynchs Crater, near the end of Fisk Road, south side (turnoff to east at south end of Malanda town). Viewpoint only. This is one of three craters (the others are Bromfield Swamp and Lake Euramoo) in which bores have been put down to give a section through the organic sediments deposited since the crater's formation. The bore cores' pollen and spores show vegetation changes and thus climatic changes during the last 60 000 years.

Stop 8. Mt Quincan. (Ask for permission to enter.) Features are the quarry on the southern side, showing bedded pyroclastic rocks with numerous olivine-rich nodules and small bombs, and the crater lake at the top of the cone. A long northwest ridge is interpreted as a pyroclastic 'tail' formed by blowing of the ash by the prevailing southeast winds.

West of Yungaburra, the road to Atherton passes through a group of small cinder cones with restricted lava fields, the Seven Sisters.

Stop 9. Lake Eacham and the nearby Lake Barrine are the best known and most picturesque crater lakes in the region. Both are maars, about 65 m deep, with well-developed ring-walls, made of outward-dipping pyroclastic beds. Lake Barrine's pyroclastics contain large blocks of schist and dolerite; peridotite and pyroxenite have been recorded in the pyroclastics from Lake Eacham. Both areas are National Parks.

Stop 10. Gillies Crater, close to the Gillies Highway, where it turns north at the top of the descent to the Mulgrave River. Pyroclastic beds exposed contain fragments of slate, schist, and other rock types from the Barron River Metamorphics. as well as basalt and peridotite inclusions.

GEOLOGY OF NORTHWEST QUEENSLAND

In the Mt Isa-Cloncurry region, a large inlier of Precambrian is represented physiographically by the Northwestern Uplands. It is flanked to the west by the Early Palaeozoic rocks of the Georgina Basin which extend into the Northern Territory. To the east are the Jurassic-Cretaceous sequences of the Eromanga and Carpentaria Basins.

In the Mt Isa Inlier, a basement succession, predominantly of metamorphosed volcanic rocks with minor intercalated quartzites, forms a central belt to just west of Mary Kathleen. The oldest formation is the Leichhardt Metamorphics (or Volcanics), consisting of acid ignimbrites with minor flow-banded rhyolites. Many of the gneisses in this formation may be metamorphosed acid lavas or ignimbrites. These rocks have been intruded by the Kalkadoon Granite. The overlying formation, also regarded as basement, is a metamorphosed basalt (Magna Lynn Metabasalt), which at the top passes laterally into the overlying Argylla Formation, of metamorphosed volcanic rocks with interbedded conglomerates. This oldest group of rocks (from Leichhardt Metamorphics to Argylla Formation) is the Tewinga Group.

Folding and granitic intrusion then took place, with the formation of two troughs, separated by a ridge of basement rocks.

In the western trough the earliest sediments (unconformably) overlying basement are conglomerates and arkoses, passing upwards into white quartzite (Mt Guide). Large-scale volcanic activity recommenced with the eruption of basaltic lavas (Eastern Creek Volcanics) with a thickness of up to 6000 m; they include a middle arenaceous unit.

A belt of metamorphosed basic volcanics and quartzites (Soldiers Cap Group) was formed to the south of Cloncurry about this time. It has been correlated with the Marraba basic Volcanics and the Mitakoodi Quartzite farther to the west.

Another thick quartzite Subgroup (Myally) was deposited in the western trough, followed by quartzites and carbonates. The formations from the base of the Mt Guide Quartzite to the top of the Myally Group are known collectively as the Haslingden Group.

In the east the Ballara Quartzite underlies the widespread Corella Formation; the latter contains a variety of calcareous, quartzite and siltstone metasediments, with calcareous rocks (now containing calc-silicate minerals and scapolite) at the base and top of the Formation. Breccias of calc-silicate rocks produced by intense deformation, with amphibolite and metamorphosed conglomerates were the host rocks for the Mary Kathleen ore-body.

More volcanics in the west were followed by uplift in the east and the deposition of sandstones, siltstones and shales. Sedimentation moved westwards, with the formation of the Mt Isa Group, which lies unconformably on older rocks. At the base is the Warrina Park Quartzite which grades up into the Moondarra Siltstone, and above that is the Breakaway Shale. Higher formations are laminated dolomitic siltstone and shale. The pyritic Urquhart Shale is host to the

stratiform lead-zinc deposits of Mt Isa. It contains thin potassic tuff marker beds.

To the north and northwest of Mt Isa sediments equivalent to the lower part of the Mt Isa Group are overlain by the Paradise Creek Formation, of basal cherts overlain by dolomitic rocks containing colonial stromatolites.

The upper Proterozoic rocks of the Mt Isa Inlier are mostly in the far northwest, in the Lawn Hill area. They are mainly sandstones, limestones, shales, and oolitic iron ore, which have been folded gently along east-west axes.

Deposits of the Georgina Basin, ranging from uppermost Proterozoic to Ordovician with a small area of Devonian rocks, are to the northwest, west and south of Mt. Isa. The oldest rocks are along the southern margin (e.g. near Duchess), and comprise glacial, dolomitic and sandstone sediments. A succession of limestones, dolomites, siltstones and sandstones follows including the Middle Cambrian Camooweal Dolomite and Thorntonia Limestone. Some of these are richly fossiliferous, containing Cambrian trilobites, Cambrian and Ordovician molluscs, as well as echinoderms, ostracods etc.

Most of the strata are marine, shallow water deposits, generally very slightly folded, with dips rarely exceeding 10^{o} on fold limbs. Phosphate has been mined south of Duchess in the Beetle Creek Formation, which has its type area west of Mt Isa.

Tertiary sediments are developed in small basins and along some river valleys e.g. Georgina and Burke Rivers. They include sandstones (often silicified), mudstones, siltstones, lacustrine limestones and calcareous spring deposits.

29. MT ISA DISTRICT

(Compiled by R.E. Russell)

The four selected tours cover the stratigraphic sequence of the Western Succession of the Mt Isa Inlier near Mt Isa, from basement to the Mt Isa Group. Tour 1 crosses the lower part of the sequence, Tour 2 includes higher formations. Those with limited time, or those interested only in the Mt Isa Group, should take Tour 3.

TOUR 1: EAST OF MT ISA (see Geology Map Sheet 6856, 1 : 100 000, Mary Kathleen).

Take the Barkly Highway east from Mt Isa towards Cloncurry, passing the Overlander Hotel (0.0 km) at the east edge of the town, the Lake Julius turnoff (17.1 km), the East Leichhardt River (signposted Leichhardt River, East Branch) at 31.1 km, and on into a narrow valley between two high quartzite ridges where a good place to turn around will be found at 35.5 km.

Stop 1. Turnaround point. Base of the Eastern Succession of the Mt Isa Inlier. The high quartzite ridges are fault-repeated bands of Ballara Quartzite, the local base of the Mary Kathleen Group. The separating fault roughly follows the road but shearing is evident in the road cuttings on the east side (right hand side proceeding towards Mt Isa). Set trip meter to 0.0 km.

Stop 2. (0.7 km). Sliver of Argylla Formation between Ballara Quartzite ridges, found in low hill on right hand side of road. This sliver of basement Argylla Formation, very similar to those in **Stop 3**, provides convincing proof of the fault-repeated nature of the quartzite ridges.

Stop 3. (1.6 km). Argylla Formation. The road has turned west out of the quartzite ridges into low but rugged hills of Argylla Formation. Here are found pink quartz-feldspar porphyries in abundance, though quartzitic sediments and rhyolitic lavas are abundant elsewhere. Uranium-lead in zircon dating gives an age of around 1780 m.y. for the unit.

Stop 4. (3.8 km). Magna Lynn Metabasalt. The road cutting shows amphibolite cut by granitic dykes. The Metabasalt, at only a few hundred metres thick, is much thinner than the several thousand metres of the other Tewinga Group formations.

Continue west through Leichhardt Metamorphics to the East Leichhardt bridge (4.4 km) and then to:

Stop 5. (5.1 km). Turnoff south to East Leichhardt Dam. Rhyolitic to dacitic lavas are well exposed on a low hill, north side of the highway. The metamorphic grade is low, and there are proposals to rename this part of the sequence the Leichhardt Volcanics. Zircon dating gives an age of about 1865 - 1870 m.y.

Continue west along the highway through Leichhardt Metamorphics, with an infaulted hilly inlier of Ballara Quartzite to the north at about 6 to 7 km, then into Kalkadoon Granite at about 8 to 10 km from **Stop 1**. After a straight section of highway, park off road at the first curve, in a wide shallow cutting.

Stop 6. (11.6 km). This is the east side of a large block of Leichhardt Metamorphics surrounded by Kalkadoon Granite, probably representing a roof pendant in the batholith. Heavily altered metadolerite occurs here with recrystallized but undeformed felsic lavas.

Stop 7. (13.5 km). Gneissic Leichhardt Metamorphics with granitic dykes and pods. Bouldery low ridges and flat rocky outcrops of intensely deformed quartz-feldspathic gneisses are developed; the thin granitic veins can be intensely folded.

Continue along highway to road sign 'Unfenced Road. Beware of Stock' at 16.6 km and park 100 m beyond at top of low ridge.

Stop 8. (16.7 km). About 20 m off road to the south, a large boulder of Kalkadoon Granite has been split for age dating and shows two phases, granodiorite and leucogranodiorite, in contact. A boulder field is found 50 - 100 m farther south. Zircon dating of the batholith gives an age close to that of the Leichhardt Metamorphics, suggesting that the Granite has intruded its own lavas.

Stop 9. (17.3 km). An optional stop on the next low ridge west, with Kalkadoon Granite boulder fields on both sides of the road.

Continue west past Lake Julius turnoff and Gorge Creek (19.4 km) to:

Stop 10. (21.5 km). Yappo Formation or Yappo Member of the Mt Guide Quartzite in a low ridge about 30 m south of the highway. The rocks here have a pervasive mica sheen, hinting at modest metamorphism, and are developed from a lithic siltstone. The unit is at the base of the Western Succession and has a maximum age of about 1790 -1800 m.y. Continue along highway through ridges of Yappo Formation.

Stop 11. (22.1 km). The low-lying Yappo unit is to the east and southeast, whereas the high ridges to the north and southwest are Mt Guide Quartzite. To the northwest is a downfaulted wedge consisting of Eastern Creek Volcanics forming low rugged hills. The Mt Guide Quartzite can be inspected 100 m to the north, across Gin Creek.

Continue west along the highway through Eastern Creek Volcanics, here metamorphosed to greenschist grade though schistosity is not developed. The greenstones are chlorite-albite-actinolite rocks.

Stop 12. (31.3 km). A major dolerite/gabbro dyke or sill in Eastern Creek Volcanics in a road curve; the intrusion is more than 20 km long and more than 1000 m thick in the centre. This stop is in metamorphosed gabbro. 200 m to the west, boulders of massive fresh metabasalt (Eastern Creek Volcanics) on the north side of the road in a minor creek contain specks of chalcopyrite.

Stop 13. (34.6 km). Eastern Creek Volcanics near causeway over Breakaway Creek. Park on east side of causeway. On the west bank of the creek is a rocky outcrop of amygdaloidal metabasalt with amygdales frequently more than 20 mm across. Quartz is the main filling.

Stop 14. (35.4 km). Moodarra Siltstone near the Overlander Hotel. Deeply weathered laminated yellowish siltstone, now mostly clay, at the base of the Mt Isa Group. A ridge of the Lena Quartzite Member of the Eastern Creek Volcanics lies immediately to the south, with a quartz-filled fault zone at its north end displacing the Quartzite across the road to another ridge in the northeast. At this location several thousand metres of the Myally Subgroup are missing; much of this can be inspected in Tour 2.

TOUR 2: NORTHEAST OF MT ISA (See Geology Map 6856 and 6756 Mt Isa; Fig.40)

Take the Barkly Highway north from Mt Isa to the Lake Moondarra Road turnoff and there set trip meter to 0.0 km. Follow the Lake Moondarra Road to the Stony Creek causeway (4.4 km) then proceed slowly for about 250 m to a rather obscure bush track to the right at 4.65 km. (NOTE: **only four wheel drive vehicles** should be used on this track as the last part is very rough; conventional vehicles should proceed directly to **Stop 7**). Follow the track 0.75 km to a T-junction (5.4 km from Barkly Highway turnoff) and turn left down the stem of the 'T'. The track then proceeds down-sequence to the Eastern Creek Volcanics.

Stop 1. (6.5 km). The track has been crossing non-outcropping to very poorly outcropping Moondarra Siltstone but at this point and nearby a low hill of slightly sandier siltstone occurs 50 - 100 m to the south, or right, of the track.

Stop 2. (7.2 km). A poor example of Warrina Park Quartzite, at the base of the Mt Isa Group, can be found on the west slope of the high ridge on the left of the track. (Much better outcrops at **Stop 7**). The bulk of the hill is in Surprise Creek Formation, a sandy unit conformably underlying the Mt Isa Group.

Stop 3. (7.6 km). The hill on the right shows a typical weakly ferruginous lithic sandstone of the Surprise Creek Formation. The track then follows a valley in the same Formation.

Stop 4. (8.0 km). A white quartzite immediately before a gate is the Whitworth Quartzite, the top unit locally in the Myally Subgroup; it forms high ridges to the left and right of the track. The track then climbs through a saddle in the ridges before dropping into a valley.
Stop 5. (9.3 km). Bortala Formation. This is a poorly outcropping, valley-forming sandstone and siltstone sequence, the middle unit of the local Myally Subgroup. Here there is a good exposure of grey siltstone on the right. High quartzite ridges to the left are Whitworth Quartzite, those to the right are Alsace Quartzite, the basal unit of the Myally Subgroup.
Stop 6. (9.8 km). Top of the Eastern Creek Volcanics in a ridge to the left and continuing for several km along the track. This is a part of the Volcanics not present in the Tour 1 sequence. Return to the Lake Moondarra Road, turn right and proceed to Lake Moondarra, about 10 km away.
Stop 7. Warrina Park Quartzite at T-junction in road, with traffic islands, Lake Moondarra. This quartzite, which conformably overlies the Surprise Creek Formation, extends parallel to the road to the left and right of the junction, with a quarry to the left and ample parking at a kiosk to the right. To the south is a good exposure of sandy Surprise Creek Formation.

TOUR 3: THE MT ISA GROUP AT MT ISA (See Fig.40)

The Mt Isa Group in this area is a steeply west-dipping sequence more than 4000 m thick. Owing to access restrictions the tour does not show the top of the sequence.
Stop 1. Eastern Creek Volcanics (see **Stop 13**, Tour 1).
Stop 2. Moodarra Siltstone (see **Stop 14**, Tour 1).
Stop 3. Warrina Park Quartzite. After leaving **Stop 2**, turn right into Abel Smith Parade (opposite Overlander Hotel) then right after about 1 km into Nathan Street (last street before the Breakaway Creek bridge) and continue beyond the bitumen down a dirt track into the bed of Breakaway Creek. Walk downstream about 100 m to where a rock bar of conglomerate outcrops. This conglomerate, here about 1 m thick, is the base of the Mt Isa Group; underlying it is the Lena Quartzite Member which forms the ridge immediately east of the conglomerate though it is poorly expressed in the creek.
Stop 2A. Top of the Moondarra Siltstone. Return to and turn left into Abel Smith Parade then turn right into George Street then turn first left, first right and first left into William Street. Park beyond the crest in William Street. The road cutting on the right (west) shows brown and buff-coloured, medium to coarse banded, deeply weathered siltstones with limonite pseudomorphs after pyrite. Sedimentary structures and a well developed cleavage are present.

Return to Abel Smith Parade and drive north; turn right at a T-junction with Sunset Drive, then second left into Enterprise Road. Follow this road past the right angle bend immediately before the hill and on to the junction with Davis Road.

Stop 4. Breakaway Shale, near top of sequence. The Davis Road exposure shows laminated siliceous shale in hillsides, road cuttings and off-road scrapings. The rocks are strongly cleaved, variably leached and oxidized, the black patches

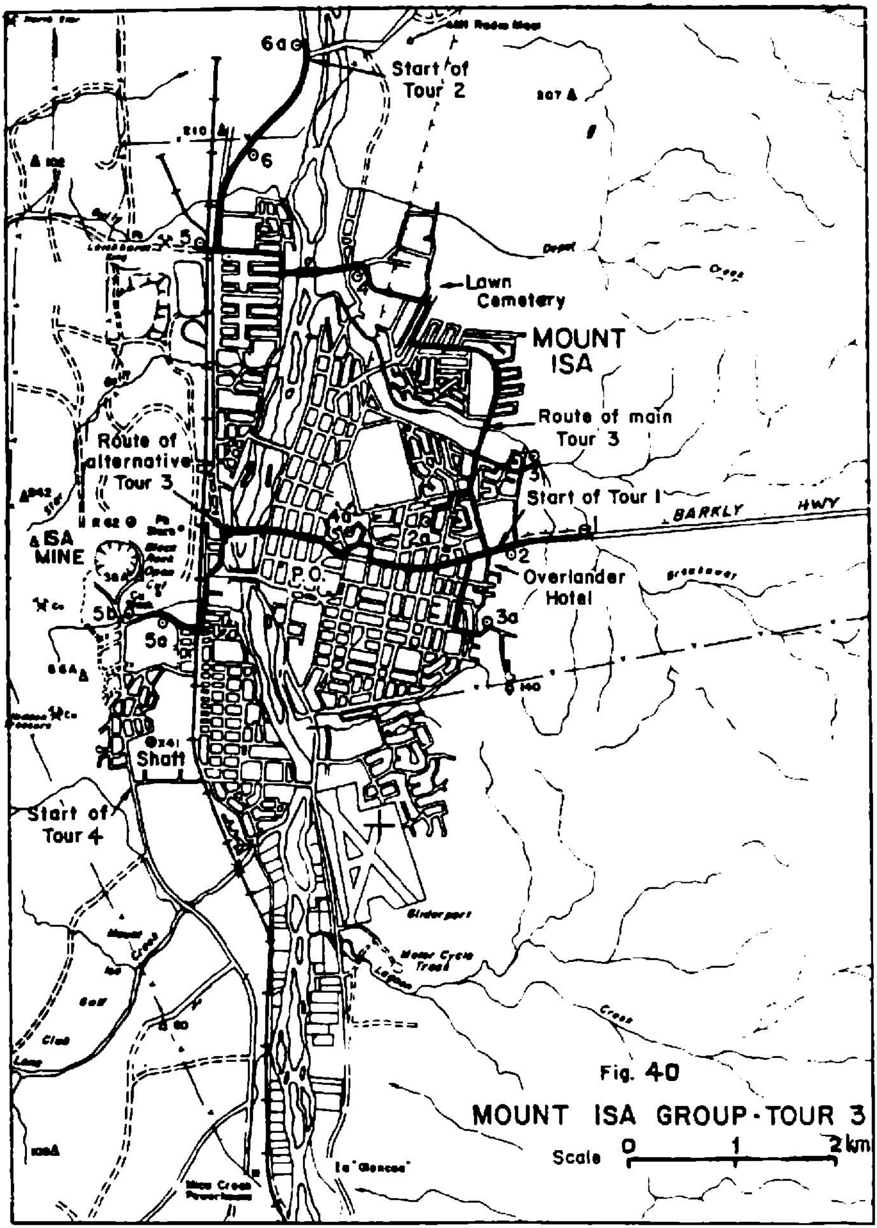

Fig. 40. Map of the Mt Isa area, showing some excursion stops.

retaining carbon. The ridges to the north and south are characteristic of this unit.

Continue west along Davis Road across the causeway to the T-junction with Urquhart Street and turn right, then take the second turn left into Milne Bay Road and follow this to the Barkly Highway. Turn right and park.

Stop 5. Railway underpass opposite Milne Bay Road. The cutting shows more than 200 m of the stratigraphy of the lower Urquhart Shale: finely laminated west-dipping grey and light brown shales interlayered with lesser siltstone; these are now deeply weathered to clays, the brown staining is due to oxidation of ferroan dolomite. The siltstone bands show sedimentary structures, especially cross bedding.

Formations lying above the Urquhart Shale are not readily accessible. Part of the Kennedy Siltstone can be seen about 1 km west of **Stop 5** along the May Downs Road.

Stop 6. Barkly Highway about 1 km north of **Stop 5.** This road cutting shows deeply weathered yellowish dolomitic siltstones at the top of the Native Bee Siltstone formation, which now consist predominately of clays. Some current bedding and other sedimentary structures are shown.

Stop 6A. About 1 km north, just north of Lake Moondarra turnoff. The middle part of the Native Bee Siltstone is well exposed in an extensive road cutting.

An alternative, or a supplementary tour can be undertaken starting with **Stops 1** and **2**, followed by **3A** and **4A.**

Stop 3A. South from the Barkly Highway west of **Stop 2** along Doughan Terrace and east along Pamela Street uphill to a parking bay opposite a large water reservoir. The knoll alongside has immature quartzitic conglomerate underfoot; it is well exposed in the creek to the north, which also shows the contact with Moondarra Siltstone. The quartzite cobbles are from the Lena Quartzite which forms the hill to the east. The conglomerate is correlated with the Warrina Park Quartzite.

Stop 4A. Mt Isa Lookout, access from the Barkly Highway (Marian Street) via Mullan and Hilary Streets (right, left then right turns). The ridges on which the lookout is located are of Breakaway Shale, a grey-brown thinly laminated siliceous shale.

Stops 5A and **5B** (Fig. 40) are in Urquhart Shale, showing more features than **Stop 5,** including ironstone outcrops, but require permission to enter from Mt Isa Mines Ltd.

TOUR 4: SOUTH AND SOUTHWEST OF MT ISA (See Geology Map Sheet 6756, Mt Isa, Fig. 40).

Take the road to Dajarra and Boulia starting at the southwest of town and set trip meter to 0.0 km at the junction of Oban Road and Link Road (near X41 Shaft). Head south towards Mica Creek Powerhouse, diverging right at a Y-junction at 3.3 km and proceeding to 4.8 km. The road has been following approximately along strike in the middle Mt Isa Group to 4.7 km, where it crosses the (non-outcropping in this area) Crystallena Fault onto the Crystallena Block. This Block contains a substantial section of Eastern Creek Volcanics

(ECV) and represents an upfaulted portion of the greenstone basement at Isa Mine.

Stop 1. (4.8 km). Road cutting in a siltstone band in the ECV. This is typical of the siltstones, often of a purplish colour, occurring in parts of the ECV sequence but not well explored on Tour 1. Proceeding to the southwest, low grade metabasalts can be seen in road cuttings but outcrop is poor.

Stop 2. (6.8 km). Road cutting between off-set blocks of Lena Quatrzite Member. The Quartzite can be seen as ridges to left and right of the road, and the off-setting fault is visible in the road cutting, along with sheared and weathered greenstone.

Stop 3. (8.8 km). Mt Isa Fault, but shown as the Mt Novit fault on most current maps. The fault is present near the eastern edge of a road cutting and is present as a strongly sheared and deformed zone of no great thickness. The rest of the cutting consists of Surprise Creek Formation . (See Tour 2 for more detail). To the east (or left) of the cutting are poorly outcropping metabasalts.

Proceed south past Mica Creek track turnoff at 9.8 km and the Mica Creek causeway at 9.9 -10.0 km to an off-road parking bay at 14.5 km.

Stop 4. (14.5 km). Judenan beds. The Judenan beds is a 'garbage' term for ridge-forming quartzites and quartz-mica schists and a number of related rocks of various stratigraphic correlations. The stop lies at the eastern edge of the first ridge and exposes an excellent road cutting of strongly folded phyllite with at least two generations of folding. The cutting is topped by a fine example of hill creep. The route is then westward to 14.8 km through a road cutting of typical micaceous quartzite. Current thinking is that these rocks lie at or immediately below the base of the Mt Isa Group.

Proceed southwards through varied amphibolites and quartzites to the Sybella Creek crossing at 16.7 km. About 100 m past the causeway there is a turnoff to the right onto the immediately adjacent Sybella Granite.

Stop 5. (14.7 km). At the poorly exposed contact between Sybella Granite and Judenan beds. A rugged ridge of typically bouldery Sybella Granite is seen to the west, with a poorly outcropping flat selvedge of granite about 100 - 200 m wide closer to the road. A low quartzite ridge (Judenan beds) occurs to the east of the road. This outcrop pattern is typical of the eastern margin of this pluton (Queen Elizabeth Pluton) of the Sybella Granite batholith. Zircon dating of the batholith gives an age of 1670 m.y., closely comparable with that of the Urquhart Shale.

Return to the Mica Creek turnoff and reset trip meter to 0.0 km. Proceed west up Mica Creek to a crossing at 0.6 km, passing through a Judenan quartzite ridge most of the way.

Note 1: tracks beyond this point are only intermittently maintained and a four wheel drive vehicle is advisable if the conditions for the tracks are unknown. When fully maintained these tracks are easy for conventional vehicles.

Note 2: ownership of the numerous pegmatites on this traverse is constantly changing. At present (mid-1984) many are in the public domain. Current ownership should be ascertained at the Mining Warden's Court in the Mt Isa Courthouse before specimen collecting is undertaken.

At 0.7 km from the bitumen road a Y-junction is reached. Take the left turn onto a bush track and proceed along it to the Queen Elizabeth Mine at 3.3 km.
Stop 6. (3.3 km). Queen Elizabeth Tin Mine. This is a small pit in a pegmatite at the contact between granite and poorly outcropping amphibolites of the ECV. The granite has the typical broad selvedge of the Queen Elizabeth Pluton, backed by a rugged ridge. Large aplite dykes are present near the ridge. The mine has been largely cleared of cassiterite which is now found only in the west wall; the more widespread tourmaline might cause initial confusion. The pegmatite itself has excellent perthite and fine books of mica.

Return to the main track at 5.9 km and proceed west and then northwest along the main track, crossing Mica Creek at 6.8 km and then crossing back and forth across a large tributary creek to a T-junction at 11.5 km. Prior to the T-junction, the track passes approximately parallel to the edge of the granite, crossing granite and amphibolite and passing near a number of pegmatites. The amphibolites are highly metamorphosed ECV. Several profitable stops could be made along the way. From the T-junction turn right and proceed for 2.1 km to:
Stop 7. (13.6 km). Big Beryl Mine. This is now a collapsing pit in the side of a small hill that formerly produced substantial tonnages of beryl. Books of mica and fragments of beryl can still be found lying about. This is an example of the predominant beryl pegmatites of the area, while the tin-bearing pegmatites such as the Queen Elizabeth are in a small minority. Beryl and cassiterite are never found in the same pegmatite.

Return to the T-junction (15.8 km), which is on a large pegmatite body of current maps. Proceed along the west track to 16.2 km at a creek crossing.
Stop 8. (16.2 km). Granite-amphibolite contact area. The contact is poorly exposed but granite to the west and amphibolite to the east may be inspected. The granite is an outlying sheet from the main Queen Elizabeth Pluton to the south, and the amphibolite is middle amphibolite grade ECV.

Continue on to the west to a 'buck' quartz pod at about 16.7 km, typical of many such pods in the area, and then onto Mt Guide Quartzite which continues to 17.1 km.
Stop 9. (16.8 km). Mt Guide Quartzite. The sequence here, though much thinned and much more highly metamorphosed, is recognisably the same as in Tour 1 east of Mt Isa between **Stops 10** and **13**, but is east facing and therefore forms the west limb of a regional syncline. The quartzite is strongly recrystallised and frequently glassy.

The low ridge of Mt Guide Quartzite at about 17.0 km marks the divide between the Gulf of Carpentaria and the Lake Eyre drainage systems. Continue to about 17.5 km, where an ill-defined track leads to the right. Those who miss this track should continue to a gate at 18.0 km then turn back 0.5 km. Do not pass through this gate onto May Downs Station. Once the side track has been found, follow it 0.3 km to a creek which drains westward.
Stop 10. (17.8 km or 18.8 km). May Downs Gneiss. This is the probable equivalent of the Yappo sequence of **Stop 10** on Tour 1. Abundant deeply weathered outcrops occur along the creek, along with an occasional thin amphibolitic metadolerite. Farther downstream, sillimanite needles can be found.

HIGHWAY GEOLOGY

1. ROUTE 1 (SOUTH): PACIFIC HIGHWAY (TO COOLANGATTA)

The route is over Neranleigh-Fernvale beds, except for Triassic-Jurassic shales and sandstones at Upper Mt Gravatt and Slacks Creek, and Tertiary sediments and basalt at Eight Mile Plains. Stopping is not allowed on the Freeway and is hazardous on most other sections of this busy highway.

The best roadside outcrops of Neranleigh-Fernvale beds are 0.5 km past the first Pimpama turnoff, where bedded black shales have been sampled for age dating. Other outcrops, of greywackes and slates, are seen along the Nerang bypass, about 64-70 km from Brisbane (park well off road if stopping).

Places of interest close to the highway include Burleigh Heads National Park, an outlier of Miocene basalt, showing columns, and the headland at the south end of Kirra Beach, where Neranleigh-Fernvale shales with near-vertical layering are unconformably overlain by Miocene basalt. Other localities for basalt are Point Danger (old quarry), Mt Murraba (Coolangatta) and the Razorback (viewpoint). See also 'The Ancient History of the Gold Coast', prepared for Gold Coast City Council by H.W. Herbert and N.C. Stevens, 1983.

2. ROUTE 1 (NORTH): BRUCE HIGHWAY (TO CAIRNS)

The first 13.5 km to Aspley are in Neranleigh-Fernvale beds and Triassic rocks (Excursion 1), then the route is over a small Tertiary basin (Petrie Formation, no outcrops) to the Pine River. From this point to Nambour, the cuttings show mainly the Jurassic Landsborough Sandstone. Low level (?Pliocene) laterite mantles the sandstone in the south; the volcanic plugs and intrusive rocks of the Glass Houses (Excursion 16) are in this area. North Arm Volcanics occur between Nambour and Eumundi and Triassic Kin Kin Phyllite is seen in weathered cuttings between Eumundi and Coles Creek. Tertiary strata (poor outcrops) overlie these beds past Cooroy and near Pomona. Permian and Early Triassic sedimentary rocks make up the low-lying country along the Mary River valley; outcrops of Permian may be seen at Gympie near the Kandanga turnoff (tuffs), opposite the Golf Club 3.8 km farther on (limestones), and just before the Kilkivan turnoff (well bedded siltstones, on the left hand side). More Permian limestone, in an overturned fold is exposed in a deep cutting 1.4 km past the Kilkivan turnoff.

The highway then passes over Jurassic Tiaro Coal Measures (dipping beds 14.5 - 15 km past the Kilkivan turnoff) and climbs over the Gunalda Range, formed from Jurassic intrusive andesite. The route is then over Tiaro Coal Measures again, Grahams Creek Volcanics and Cretaceous Maryborough Formation. Several cuttings between 15 and 16.5 km after the top of the Gunalda Range show dipping beds. Few exposures are seen between Maryborough and Isis River as the route is mainly over the Burrum Coal Measures.

Approaching Childers, the road passes over Maryborough Formation sandstones and shales, with deep red soil 2.2 km north of Childers. The red soil is from Tertiary basalt, overlying granite with porphyry dykes. Pleistocene basalt is crossed near Wallaville. From here to Gin Gin, Permian Gympie Group, Brooweena Formation sandstone and granite are passed over. Another flow of basaltic rocks (?late Tertiary) makes a flat surface 21-25 km past Gin Gin (outcrops with radiating columns are exposed 1.7 km from the highway along the road to Fred Haigh Dam).

Much of the country traversed from the Kolan River to Miriam Vale and the Boyne River is granitic; the road then enters a belt of slaty Curtis Island Group and turns northwesterly, crossing belts of Devonian Calliope beds (to the Calliope River) and Carboniferous strata (for 8 km past the river). For most of the way from here to Bajool, the route is over Early Devonian Mt Holly beds (tuffs, flows, siltstones, mudstones, conglomerate and limestones) followed by Carboniferous Rockhampton Group, with a lesser volcanic component. The same rocks occur along the road north of Rockhampton with some Permian Berserker beds.

Limestone caves near Cammoo and the limestone of Mt Etna (seen on the right 2 km after the turnoff to Cammoo Caves) are in the Devonian Mt Holly beds. Large masses of serpentinite occur between Canoona and Marlborough but few outcrops are seen along the highway - one of these is 18 km past Yaamba, near Glen Geddes. Palaeozoic schist and phyllite between the serpentinite masses are exposed in a cutting 7 km past the Canoona Goldfields Memorial (on the right).

Marlborough-Wumalgi turnoff (first 70 km): Permian sandstone, siltstone, tuffs of the Back Creek Group with overlying Cretaceous Styx River Coal Measures.

Wumalgi turnoff-Sarina: Permian Carmila beds (mainly tuffs and breccias) except for some Back Creek Group at the first turnoff to St Lawrence. Breccia and dacite tuff (the latter in large boulders on the right) occur between the Kalarka turnoff and the southern entrance to Clairview, and coastal exposures of the dacite tuff are seen by taking the minor road and stopping 0.9 km past the Caravan Park. Dip slopes of Carmila beds (easterly) are to the north, with cliffs to the west of the road (seen by taking the Upper Flaggy Rock Road for less than 1 km). West of Mt Christian, granite intrudes Campwyn beds (see Excursion 26).

Sarina-Mackay: Campwyn beds for 10 km past Sarina, with a granite mountain to the right.

Mackay-Proserpine: Microdiorite and intruded rocks for 10 km past North Mackay, rhyolite at The Leap, and Permian Calen Coal Measures from Parapi to east of Mt Ossa. Mt Pelion and Mt Ossa to the west are of Permian Lizzie Creek acid-intermediate volcanics. Carmila beds from Pindi Pindi to Yalboroo, then Calen Coal Measures and Carmila beds again to 10 km past Bloomsbury, 5-6 km of Campwyn beds, then flat country to Proserpine and beyond.

Proserpine-Townsville: Over Carboniferous volcanics and sedimentary rocks 10 km past Proserpine, few outcrops to Longford Creek (mainly over alluvium

and Tertiary sediments) then Carmila beds for a few km and granite to Bowen. The alluvium of the Don Rover is crossed, then rugged granite country west of Bowen (Sprole Castle). Granite interspersed with alluvium continues to Guthalungra and Mt Inkerman, and gabbro is exposed in cuttings after Kyburra (12.5 km past Guthalungra). Carboniferous-Permian volcanics are the main outcrops close to the highway between Cromarty and Townsville with granitic rocks making the higher country. (Feltham Cone and Saddle Mountain on either side past Cromarty, and Mt Stuart).

Townsville-Cairns: Along the coastal plain to Rollingstone and Ingham with ranges to the west (including Mt Spec National Park) of granite and Carboniferous rhyolite. View of Hinchinbrook Passage and Island from the Cardwell Range (Hinchinbrook Island is also mainly of granite and rhyolite). Barron River Metamorphics (phyllites, schists) are first seen 18 km north of Tully but also occur at Mourilyan. Pleistocene basalts overlie the metamorphics 15 km north of Innisfail and the latter are found as far as Babinda, where granite makes up the Bellenden Ker Range to Aloomba and Walshs Pyramid (south of Gordonvale). Barron River Metamorphics continue to Cairns and north almost as far as Port Douglas. Green Hill, a small composite volcanic cone of Pleistocene age, rises from the plain 13 km south of Cairns.

3. ROUTE 15: CUNNINGHAM AND NEW ENGLAND HIGHWAYS (TO WALLANGARRA)

As far as Ipswich the route (Ipswich Road) is mostly over Triassic sedimentary rocks alternating with overlying Tertiary sediments and volcanics (Excursion 8). Few outcrops are seen before Woogaroo Creek, near Gailes. Between Gailes and Riverview the Triassic rocks belong mostly to the Raceview Formation (Bundamba Group), with the best exposure on the Redbank bypass. Past Riverview the road is on Tivoli and Blackstone Formations of the Ipswich Coal Measures, and on Tertiary clays at Dinmore and south of Booval. Past the southern end of the Tertiary Booval Basin, the new Ipswich bypass crosses Ripley Road Sandstone and Marburg Formation in a zone of faulting and steep dips. To the west, dips are gentler in the overlying Jurassic Walloon Coal Measures, which form the basement for the Tertiary Main Range Volcanics.

Palaeocene basalts occur in cuttings on the approach to Mt Walker Creek and numerous poor exposures of weathered basic intrusions occur between this point and the foot of the Main Range (e.g. hilltop quarry on the right, 2.3 km past Mt Walker Creek). The only good exposure of Walloon Coal Measures in this area is a narrow cutting (traffic danger) 3.4 km past the Kengoon turnoff, where shales and lithic and nodular calcareous sandstones have been intruded by a vertical trachyte dyke (north end) and a slightly trangressive dolerite sill (south end). More intrusive rocks are seen past Aratula at the foot of the range (basaltic dyke and sill at 11 km, trachyte sill intruded by basalt dyke at 12 km) and on the ascent (at 12.6 km and13 km).

The base of the Main Range Volcanics is at Clayton Gully, but is not exposed because of soil, vegetation and trachyte scree from above. From Bell Bird Park, basalt flows of the Main Range Volcanics, some with red, weathered tops, can be seen in the cliffs of Mt Mitchell. At Cunninghams Gap a bed of trachytic breccia occurs 100 m downhill (on the east side). Coarse gravels containing trachyte boulders (at 7.2 km past the Gap) and bedded tuffs (at 13.8 km) are interbedded in the basalt sequence. The Walloon sandstone reappears at 3.4 km past the Maryvale turnoff, not far past a shallow quarry in red bole, probably developed on one of the lowermost basalt flows. The first few cuttings past Warwick are in Marburg Formation sandstones. The lower beds are conglomerate which overlie granite 14.5 km from Warwick (past Glen Creek). The long uphill section 8 km farther on is through granite, with a porphyrite dyke; contact metamorphosed sedimentary rocks of the Carboniferous Texas beds have been intruded by a granite dyke at the top of the hill. Similar beds, some showing steep dips, continue for more than 3 km before more granite country is traversed. Near Dalveen, Jurassic sandstone overlies the granite.

The most prominent outcrops of granite on the highway are on the Stanthorpe bypass; other areas of large tors and dome-shaped hills are in Girraween National Park (turnoff at Wyberba for the Pyramid and other features). These are in the Stanthorpe Adamellite, a porphyritic granite member of the New England Batholith.

From Wyberba to within 1.5 km of Wallangarra, the road passes through hilly country composed of Permian rhyolitic rocks, intruded by an 'adamellite porphyrite' (between 4 and 7.3 km and between 8.7 and 9.4 km from Wyberba turnoff) a rock which shows textures of intrusive and extrusive rocks; similar rocks have been found at several sites in the New England Batholith to the south. The last 1.5 km before Wallangarra is in adamellites.

4. ROUTE 54: WARREGO HIGHWAY (TO CHARLEVILLE)

The Highway commences near Dinmore, on Tertiary clays, and after crossing the Bremer River passes onto Triassic Tivoli Formation (Ipswich Coal Measures), exposed in open cuts and near an overhead bridge. Tertiary beds, including weathered basalt, are crossed and the next cutting just before the Ipswich and Pine Mountain turnoff, is in sandstones, shales and conglomerates dipping at 40^{o} to 50^{o} to the west. These rocks are in the Aberdare Conglomerate at the base of the Bundamba Group, in a zone of faulting; they are overlain by Raceview Formation shales and a narrow strip of Ripley Road Sandstone (poor outcrops), and more Tertiary beds.

About 1 km past the Esk (Brisbane Valley Highway) turnoff, the Heifer Creek Sandstone Member of the Marburg Formation is seen in low cuttings for 2 km before the highway passes onto the flat to undulating surface underlain by Walloon Coal Measures, in a synclinal structure at Haigslea.

The Heifer Creek Sandstone is exposed in cuttings near the Marburg turnoff and on the hills to the west ('Marburg and Minden Ranges'). Outliers of Tertiary

basalt cap the hills south of Haigslea (Mt Marrow) and the highway west of Marburg.

Apart from gravels past Lockyer Creek and alluvium near Gatton, the highway passes over Marburg Formation with few outcrops to the base of the escarpment east of Toowoomba. The base of the Oligocene-Miocene basalts of the Main Range Volcanics is at a change in slope 1.6 km past the foot of the hill. On the plateau surface around Toowoomba the uppermost flows are lateritized. West of the city, basalts make up the country as far as Oakey with remnants west of Jondaryan.

Farther west around Dalby, the route is over alluvium and Tertiary-Quarternary sediments. From Chinchilla to 10 km past Miles: Jurassic-Cretaceous Gubberamunda Sandstone; thence to Charleville: Cretaceous Wallumbilla Formation (mudstone, some siltstone, minor limestone and glauconitic sandstone) and laterite.

5. ROUTE 17: BRISBANE VALLEY, D'AGUILAR, AND BURNETT HIGHWAYS (TO GAYNDAH AND MT MORGAN)

The highway commences at the Esk turnoff from Highway 54, northwest of Ipswich and remains on Marburg Formation sandstones for most of the way to Wivenhoe Dam and then alternates between areas of Helidon Sandstone and Esk Formation (conglomerates, shales, sandstones, tuffs) before passing onto Neara volcanics (andesites, boulder beds) near the junction with the old highway, and back onto Esk Formation again past Paddys Gully. The hills to the right (Mt Esk) are Jurassic intrusive rhyolites.

The route north is along the Esk Trough, in Esk Formation to the Blackbutt Range; moderately steep angles of dip can be seen 4 km past Moore. From Benarkin to Nanango the highway passes over granitic rocks, intrusive into Permian andesite 50 m past Salty Creek, and Palaeozoic metamorphic rocks of the Yarraman Block, overlain by Tertiary basalt, 6 km past Yarraman. Lateritic weathering, producing thick red soils and mottled zones, is developed on basalt and granite. 20 km past Nanango, the road re-enters the Esk Trough, passing over Esk Formation onto Neara Volcanics. Past Marcella Creek, a cutting shows dipping conglomerate beds, and 2 km farther on, rhyolite overlying (and perhaps intrusive into) andesite. A hilly section after 'Holroyd' turnoff (left) is in Triassic rhyolitic rocks (Aranbanga beds). Past Sandy Creek, trachyte dykes intrude Palaeozoic siltstones and quartzites.

At Ban Ban Springs, Pleistocene basalt has flowed down an old river valley, and water issues from a porous zone. The same flow is crossed by the highway below Barambah Creek bridge, where the basalt overlies an old soil developed on a trachyte intrusion (on the old road). Triassic ignimbrite and intrusive trachyte are exposed in a cutting on the east side of the creek. Approaching Gayndah, outcrops of Triassic conglomerate, sandstone and shale (Gayndah beds), intruded by a weathered basic dyke, are on the left.

On the way to Mundubbera the road climbs the escarpment of the Binjour Plateau (laterite-capped Tertiary basalt) then descends onto Devonian-Carboniferous Wandilla Formation equivalents and Carboniferous sedimentary beds on either side of Mundubbera. To the north the Highway follows the axis of the Mulgildie Basin passing over Jurassic Evergreen Formation, then granite at Eidsvold, and Hutton Sandstone (=middle and upper parts of the Marburg Formation) around Abercorn and Monto.

The geology between Monto and Biloela has been described in Excursion 24. Tertiary sediments, with few outcrops continue from Biloela to Dululu and the road then crosses Devonian strata, first, the Capella Creek beds, which are mainly acid to intermediate tuffs with some sandstones, mudstones and limestones, then unnamed volcanics, and close to Mt Morgan Late Devonian tonalite (basic granodiorite).

6. ROUTE 13: MT LINDESAY HIGHWAY

The highway commences as Beaudesert Road north of Moorooka on Triassic Ipswich Coal Measures and passes onto the overlying Woogaroo Subgroup sandstones and shales and a Tertiary basin in which Darra Formation, basalt and Sunnybank Formation are developed, but there are few outcrops before Browns Plains (weathered basalt past the intersection, on the right). More sandstones of the Woogaroo Subgroup are to the south, overlain by Marburg Formation south of Greenbank. The structure is a south-plunging syncline, so that successively younger Mesozoic formations are met in this direction (Walloon Coal Measures 5 km south of Jimboomba). Tertiary basaltic intrusions occur close to the highway: a weathered basic dyke just past Macleans Bridge, a weathered basic (?) sill between Veresdale hotel and a rest area, and fresh basalt in plugs, to the west of the road near Jimboomba, and at Round Mountain, south of Beaudesert. Tertiary sediments have been mapped along the highway north of Beaudesert, and silcrete, a silicified sand, occurs about 10.6 km south of the town, in an area where the Lamington Group basalts are present.

South of Tamrookum, the highway crosses an anticlinal axis to the west of the syncline mentioned above, and lower formations (Marburg and sandstones of the Woogaroo Subgroup) are exposed, at and past the bridge over the railway line. Walloon Coal Measures do not reappear until Palen Creek is reached. The cliffs of Mt Ernest and Campbells Folly (rhyolitic intrusives) are seen to the right, and Mt Lindesay (an outlier of Tertiary rhyolite flows and tuffs overlying basalts) to the left, as the road ascends to the State border.

7. ROUTE 39: LEICHHARDT HIGHWAY (MILES - THEODORE - BANANA)

North of Miles the route is over Jurassic - Cretaceous Kumbarilla beds (sandstones, siltstones, mudstones etc.) to near Giligulgul, and Jurassic Injune Creek beds to Robinsons Creek, past Taroom. The road descends through Hutton Sandstone, Evergreen Formation and Precipice Sandstone (Isla Gorge Lookout),

with Triassic Moolayember Formation and Clematis Group in the gorge. Rewan Formation is crossed before Theodore, and to the north, Late Permian formations (Gyranda, Flat Top, Barfield and Oxtrack in descending stratigraphic order) outcrop to the Eidsvold Road junction, on Camboon Andesite. The same Permian formations are traversed, in reverse order, to Banana.

8. ROUTE 55: DAWSON AND GREGORY HIGHWAYS (BANANA - SPRINGSURE - EMERALD)

Late Permian Baralaba Coal Measures are worked near Moura; to the west as far as Rolleston, exposures are mainly of Moolayember Formation, then Clematis Group occurs in the Expedition Range, with some Tertiary basalts past Roundstone and Bauhinia Downs. Basalts predominate towards and beyond Rolleston, with some of the underlying Permian (Ingelara and Freitag Formations and Aldebaran Sandstone) showing 45-50 km past Rolleston.

North of Springsure, views to the west are of the Tertiary basalt escarpment (Mt Zamia) with plugs (Virgin Rock) and flows of trachyte, and to the north the Minerva Hills, of trachyte and rhyolite domes and dykes.

9. ROUTE 66: CAPRICORN HIGHWAY (ROCKHAMPTON - BARCALDINE)

The highway passes over granitic rocks past Gracemere, Carboniferous sedimentary rocks of the Neerkol Formation and Permian Dinner Creek Conglomerate just before Stanwell. Past Wycarbah, Cretaceous volcanics appear (see Excursion 25) and then granitic rocks and layered gabbro near Westwood, and Permian sedimentary and volcanic rocks almost as far as the Dawson River. Outcrops between Duaringa and Anakie are mostly Bowen Basin sediments (lateritized in places), with some Tertiary basalts. West of Anakie, Devonian and Carboniferous beds of the Drummond Basin are crossed, first the Silver Hills Volcanics, then several sedimentary formations (Telemon, Mt Hall, Raymond Sandstone, Star of Hope) in narrow belts before a wide area of Ducabrook Formation (sandstone, shale, tuff and limestone) extending past Bogantungan. Formations to the west are mudstones, siltstones and sandstones of the Joe Joe Group (p. 80), the Permian Colinlea Sandstone of the Back Creek Group 15 km past Alpha, and Triassic beds (Dunda, Clematis and Moolayember) between Beta and Jericho, all deposits of the Galilee Basin. Jurassic-Cretaceous sedimentary rocks of the Roniow beds near Lochnagar are at the margin of the Eromanga Basin.

10. ROUTE 78: FLINDERS HIGHWAY (CHARTERS TOWERS - CLONCURRY)

Granite and metamorphics are close to Charters Towers (see Excursion 27), and the few outcrops before Pentland have been assigned mostly to the Cambrian-Ordovician Mt Windsor (acid - intermediate) Volcanics. Triassic Warang Sandstone is crossed between Pentland and Torrens Creek and Wallumbilla

Formation (see Route 54) is present between Prairie and Marathon. Late Caino-zoic basalts form low ridges to the north. Early Cretaceous Allaru Mudstone continues for most of the way from Marathon to the margin of the Mt Isa Inlier about 25 km from Cloncurry.

11. ROUTES 71 AND 66: LANDSBOROUGH HIGHWAY (MORVEN - CLONCURRY)

The route is largely over the flat surface formed from the Cretaceous sedimentary rocks of the Great Artesian Basin, with few outcrops (calcareous sandstones about 38 km north of Augathella and 100 km north of Winton, the latter exposure showing spheroidal concretions). Tertiary sandstones form mesas near Kynuna; the first Precambrian mica schists and quartzite (Proterozoic Soldiers Cap Group) are seen past Fullarton River, and limestone of the Corella Formation 10 km past Williams River.

SOME ADDITIONAL AREAS OF GEOLOGICAL INTEREST IN CENTRAL AND NORTHERN QUEENSLAND

PEAK RANGE

The Range is to the east of Clermont; access to the northern part is via the Clermont - Nebo Road, to the central and southern parts by tracks from Clermont through Cotherstone, and from Capella to May Downs.

The Peaks are in two groups of conical and domical puys and vents, composed mainly of rhyolite and trachyte, including alkali rhyolites or comendites in the southern area and pitchstones in the north. In the central area plateaus and mesas are formed from flat-lying lavas, mostly basalts, but the prominent Lords Table Mtn and the nearby Anvil are capped by trachyandesite. Extensive thin sequences of basalt underlie the plain near Capella and Clermont. Eastern Peak, 16 km SE. of Lords Table Mtn, is now a National Park.

PORCUPINE GORGE

A gorge cut by Porcupine or Galah Creek, about 45 km north of Hughenden, exposes a wide range of formations, from Cambrian - Ordovician metamorphics (schists, gneisses and amphibolites of the Cape River beds) to the east of Mt Sturgeon, through Late Carboniferous and Permian glacial and freshwater sediments, Triassic Warang and Jurassic Blantyre Sandstones to marine Cretaceous beds, Tertiary river deposits, Quaternary basalt forms the plateau surface.

CHILLAGOE

A notable feature of this district is the occurrence of prominent bluffs of limestone to the south of the town, exhibiting tower karst features (pinnacles rising steeply from a plain) and deep dissection, resulting in cave systems.

Tracks northwest from the old smelters approach Bocoonbeta Mtn, one of a group of granitic hills known locally as the Metal Hills. The mountain is surfaced with rounded rectangular boulders, without soil or vegetation, similar to the Black Mountain near Cooktown.

LAWN HILL GORGES

The gorges are in Late Proterozoic Constance Sandstone, a gently-dipping orthoquartzite which is unconformably overlain by Middle Cambrian Thorntonia Limestone. Large grikefields occur in the limestones along the northern side of Colless Creek (grikes are clefts caused by solution along joints).